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World's Highest Powered Motorship
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NEW YORK

SEATTLE

MOTORSHIP

Devoted to Commercial and Naval Motor Craft

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FEBRUARY, 1919

Vol. 4

No. 2

WILLCOX, PECK & HUGHES

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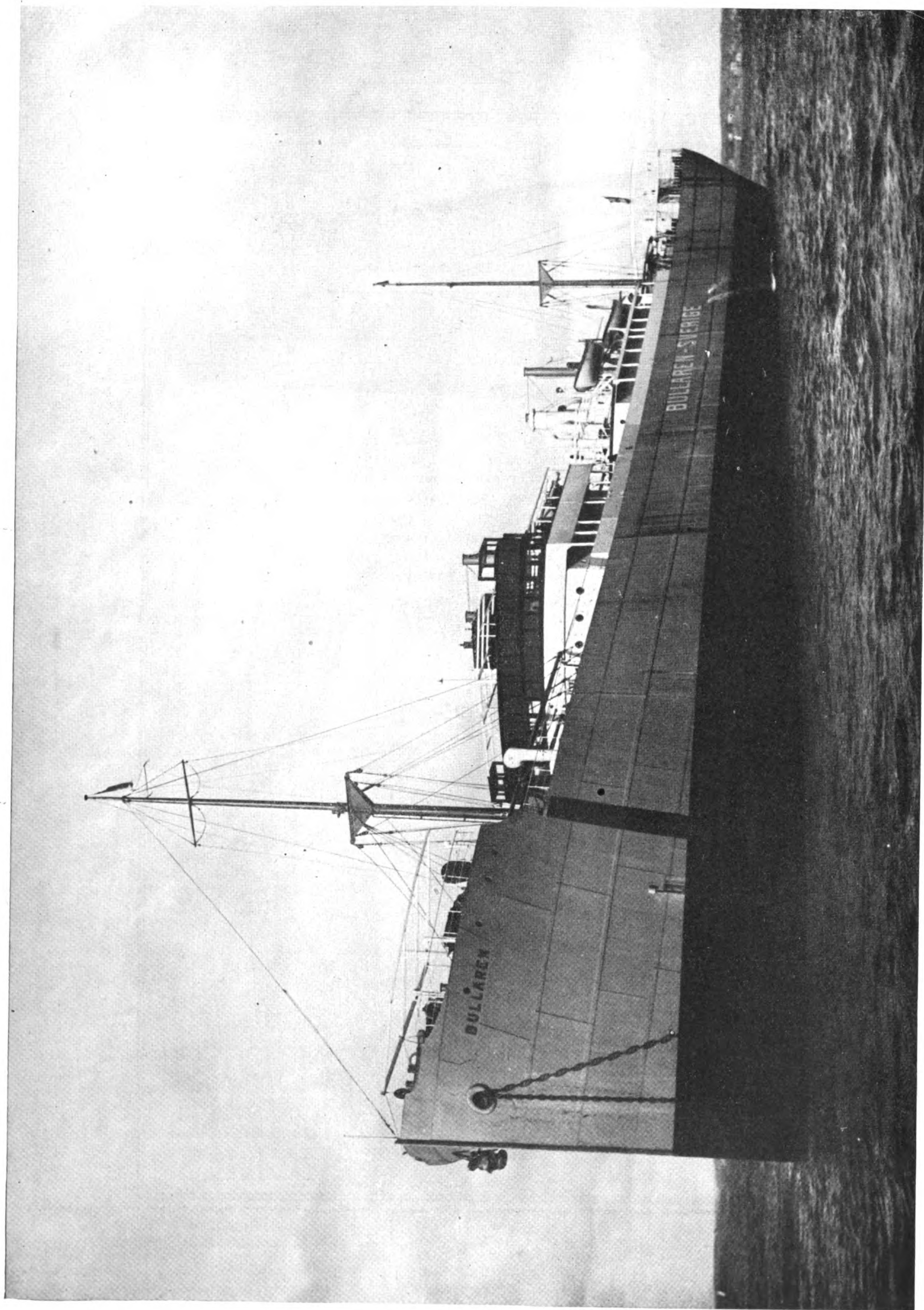
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NOTEWORTHY ECONOMICAL MERCHANT SHIPS—No. 4

The motorship "Bullaren," a 13-knot cargo and passenger vessel of 9,500 tons d.w.c. She has carried 9,000 tons of case-oil cargo, excluding fuel, water, and stores from New York to Norway on an average consumption of 11.7 tons of fuel-oil, and 114½ lbs. of lubricating-oil per 24-hour day, and in addition discharged 400 tons from her bunkers as cargo, yet retaining enough fuel for her return voyage to New York. Length BP, 425'; Breadth, 56'; Depth, 38'; Loaded-Draught, 26'. Speed on trial 12.7 knots partly loaded. Her owners are the Rederiaktiebolaget Transatlantic of Gothenburg, and she was built by the Gotaverken. Shipowners should compare her capacity and economy with their own steamships and figure out the gains and savings obtainable in one year's operation. On a 50-days' voyage the "Bullaren" could carry 2,400 tons more cargo than a coal-burning steamship of similar dimensions, if no time could be spared for the steamer to re-bunker en route. In a few years America will have hundreds of such economical motorships.

MOTORSHIP

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February, 1919 Vol. 4 No. 2

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The oil-engined motorship has arrived! It is such a pronounced economy that it was bound to come. Nothing could stop it! And all obstacles have been removed as fast as they arose. The law of progress has seen to that. Very strong prejudices stood in the way of steam. But, one after another they were swept aside and steam reigned triumphant for a century. Steam now has had its day! Its zenith has passed, and gradually but surely it is being superseded by the economical internal-combustion power. America, the most important oil-producing country, is to be the greatest motorship-owning nation. Let us all co-operate and assist to make that day soon.

EDITORIAL

AN OBJECT LESSON BY CHAIRMAN E. N. HURLEY

THERE was more than one distinct object-lesson to be found in the article on motorships versus coal-burning steamers, by Edward N. Hurley, Chairman of the U. S. Shipping Board, published in our last issue; but there is one portion so important that we cannot refrain from repeating it in order that shipowners who are considering the construction of steamers may thoroughly digest its significance before embarking upon a step which later on may be regretted. At the same time we do not think that many new steamships will be ordered by private shipowning companies, although some of the yards now can accept orders. But, as soon as the general shipping situation is a little clearer, we are confident that many large motorships will be laid down, and already three of the largest domestic shipowning concerns are taking the preliminary steps with a certain shipbuilding company. In addition, we can safely anticipate the Emergency Fleet Corporation winding up its activities with the building of a little fleet of motorships, unless the unexpected occurs.

The points brought up by Chairman Hurley upon which we lay stress are:—we quote his words verbatim:

"Two ships of the same tonnage went round the world, leaving Europe, rounding Cape Horn, touching at San Francisco, thence crossing the Pacific and going through the Suez Canal. One was a coal-burning steamer and the other a motorship. The steamer stopped for coal fourteen times and burnt 8,500 tons on the voyage. The motorship burned 1,446 tons of oil and had capacity for carrying 1,250 tons; so she might have gone nearly the whole voyage, starting with full tanks—actually she left Europe with 820 tons, and bunkered twice—in San Francisco and the Persian Gulf—but turned an honest penny by using some of the tank capacity to carry an oil cargo from one port to another."

"The steamer made the voyage in 300 days; the motorship in 236 days. The steamer carried 7,500 tons of cargo; the motorship 8,500 tons. The cost of coal—normal times—was \$41,275, and the cost of oil for the motorship was \$12,940—

a saving of nearly seventy per cent. The coal burner carried fourteen stokers; the motorship none. The motorship carried an engine-room force of thirteen men as against nineteen for the coal burner. So there was a saving in fuel amounting to seventy per cent., a saving in time of more than twenty per cent., and an increase in cargo of nearly fifteen per cent."

"These figures become most significant when reduced to terms of early operating costs. Suppose each ship costs one million dollars. The motorship saved \$28,335 on fuel in eight months. That alone amounts to about four per cent. annual interest on the entire investment in the ship."

There is no occasion to doubt in any way the figures given by Mr. Hurley, because there are instances on record where even better results have been given by motorships; therefore, such enormous economies cannot be disregarded any longer by those owners who previously may have maintained a disinterested or waiting attitude. We may frankly say that we do not believe that the U. S. Shipping Board will order a single additional coal-burning ocean-going merchant freighter, and we are of the opinion that if the Government decides that the Emergency Fleet Corporation shall continue with the construction of ships, all new orders will be for motorships with the exception of large liners. This Chairman Hurley made obvious in his final announcement before sailing for Europe in November last. We also think that before several years have past many existing steamers will be converted to motor power.

Several prominent American shipyards are now negotiating for the few remaining successful European Diesel-engine constructional licenses, and one well-known Great Lakes firm will exclusively construct standardized steel motorships which will be quite an innovation, as one size will be cut in two and shipped via the Welland Canal to the sea. They have just purchased an Italian Diesel-engine license. Other shipyards who have "stayed their hand" will be obliged to go to the expense and delay of designing and developing their own Diesel-engine, or else be content with little or no business a few years hence, if they are not fortunate enough to secure the few responsible licenses that yet have not been contracted for.

An Obsolete Measurement Term

Necessity for Discarding the Term "Dead-Weight-Capacity" in Favor of "Cargo-Carrying Capacity"

NOW that the large motorship has established for itself an important place in the world's merchant shipping, the measurement term "dead-weight-capacity," when used for the purpose of figuring the first cost or capacity of a ship, becomes very misleading. Inasmuch, if a motorship and a steamship of similar dead-weight-capacity are taken in consideration, the actual cargo-capacity of the motorship for a given round voyage of moderate length will be much greater than that of the steamer, with the result that the first cost of the motorship per cargo-carrying-ton will be less, even if her actual total cost is a little higher with the same power and dimensions. Some shipping men refer to the "lifting" power of the ship to illustrate the actual cargo capacity.

When a well-known shipowner recently said that "the efficiency of a ship is its capacity to deal with a maximum load in a unit of time at a given cost," he gave a good conception of what a ship is built for, only he might have changed the words "given" to "minimum" with advantage.

Dead-weight-capacity in the ordinary method of expressing the commercial value of a cargo-vessel for charter or purchase is intended to be a measure of her cargo-carrying capacity. It necessarily includes the weight of the fuel, water, spare-parts, crew, effects, and stores, because the ship cannot transport cargo without the above. But, compared with a steamer of the same dimensions and power, the weight of fuel and water needed by a motorship is so small—not to overlook the reduction in the weight of the machinery—that the term dead-weight-capacity immediately becomes misleading, as it is no true indication of the cargo capacities of two different types of vessels of the same size.

For instance, let us take a motorship and an oil-fired steamship of similar dimensions namely 425 ft. length b.p.; 56 ft. breadth; 38 ft. depth, and 26 ft. loaded draught. Both 13 knots speed and of 4,000 i.h.p. Voyage, New York to Gothenburg and back; distance, 7,600 nautical miles.

The steamer will have a dead-weight-capacity of 9,350 tons, including 1,300 tons of oil-fuel; 150 tons of water, and 30 tons of stores, crew, etc.

The motorship will have a dead-weight-capacity of 9,500 tons, including 1,300 tons of oil-fuel, 50 tons of water, and 25 tons of stores, crew, etc.

Obviously the steamer will have an actual cargo-capacity of 7,970 tons, and apparently

the motorship will have a cargo-capacity of 8,125 tons. But, in actual fact the cargo-capacity of the motorship will be about 800 tons greater than this figure because she will only need 400 tons of oil-fuel for the return voyage in addition to 100 tons emergency

Thus, while the motorship may cost more to build at present, and so costs more to build per dead-weight-capacity ton, **she costs less to build per cargo-carrying capacity ton.** Here, it is well to bear in mind, that the fundamental work of a ship is to carry cargo,

Comparison Between an Oil-fired Steamer and a Diesel-driven Motorship of the Same Dimensions.

(Taken from an Existing Motor Vessel)

	STEAMER	MOTORSHIP
Length O. A.....	440 ft.	440 ft.
Length B. P.....	425 ft.	425 ft.
Breadth.....	56 ft.	56 ft.
Depth.....	38 ft.	38 ft.
Draught (Loaded).....	26 ft.	26 ft.
Dead-weight-capacity.....	9,350 tons.	9,500 tons
Fuel-Capacity.....	1,300 tons.	1,300 tons
Cargo-Capacity (Maximum on 7,600 Miles Voyage).....	7,970 tons.	8,925 tons
Designed Loaded-Speed.....	13 1/4 Knots.	13 Knots
Probable Average Sea-Speed for 1 year; 11 1/2 to 12 Knots.....	12 to 12 1/2 Knots	
Power.....	4,000 I.H.P.	4,000 I.H.P.
Propeller Speed.....	85 R.P.M.	100 R.P.M.
Reserve Emergency Power.....	15 %	30 %
Cruising Radius (in days).....	33	100
Cruising Radius (in miles).....	10,296	31,200
Daily Fuel-Consumption (loaded).....	38 tons.	12 1/2 tons
Consumption per I.H.P. hour.....	0.95 lb.	0.30 lb.
Lubricating-Oil consumption per day.....	7 gallons.	12 gallons
Fresh-Water Carried (including for Boilers).....	150 tons.	50 tons
Daily Fuel-Consumption in Port.....	3 1/2 tons.	1 1/4 tons
Engine-room Staff.....	23 men.	17 men
*Annual Wages (Machinery-Staff Only).....	\$22,500	\$20,820
Total Ship's crew.....	49 Men and Officers.	43 Men and Officers
First Cost of Ship.....	\$1,400,000.00	\$1,540,000.00
First Cost of Ship per Cargo-Capacity-ton.....	\$175.65	\$172.54
First Cost of Ship per D.W.C. Ton.....	\$150.00	\$161.68

*American scale

The loaded displacement of both ships is the same.

oil-fuel supply. This surplus of 800 tons of oil in her bunkers she would discharge as cargo upon reaching Norway, which has no natural oil supply. The steamer could not spare any oil to discharge as cargo, because her consumption would be three times as great.

This gives the cargo-capacity of the motorship as 8,925 tons, compared with 7,970 tons for the steamer. Thus the motorship has an earning power on a total of 955 tons more cargo than the steamer. (Assuming \$40.00 per ton freightage, this 955 tons would represent \$38,200.00 per one way voyage additional income without any increased expense. Or, something substantial for a shipowner to think about.

Assuming that the first cost of the oil-fired steamer was \$1,400,000.00, it will be seen that the first cost per cargo-carrying-ton works out at \$175.65; but at a little under \$150.00 per d.w.c. ton.

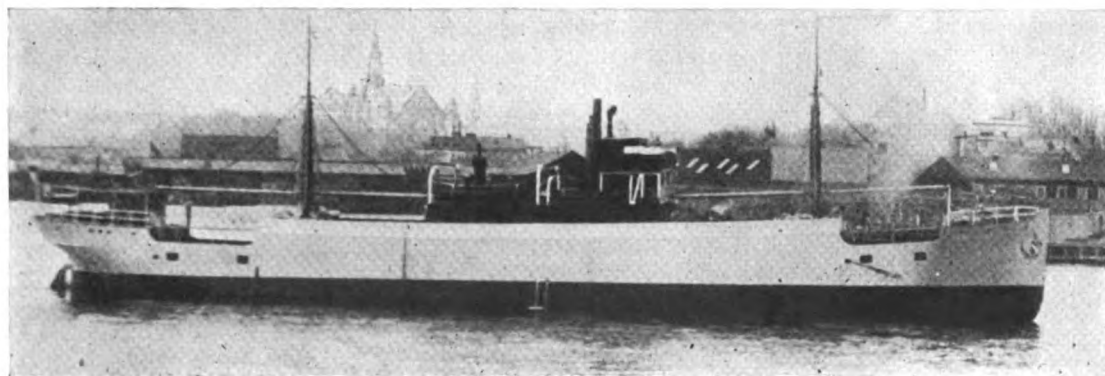
Assuming that the first cost of the motorship was higher, namely \$1,540,000.00, the first cost per cargo-carrying-ton figures out at \$172.54, but at \$161.68 per d.w.c. ton.

and that is what she is solely built for, and everything carried in addition to cargo (except passengers) represents so much dead loss on her earning power, all of which goes to show that for a shipowner who operates both steamers and motorships the term "dead-weight-capacity" has become obsolete.

With a coal-burning ship the differences are even more in favor of the motorship; but we have taken an oil-fired steamer in order to make the fairest comparison.

We should mention that the cubic-capacity of the motorship is greater because of the saving in machinery and water space. On longer voyages than the one quoted, the motorship will show to greater advantage, because the steamship would have to use her deep-tank for fuel, whereas the motorship could carry cargo in her deep tank, because the fuel in her double bottoms and wing tanks is sufficient for 100 days at 13 knots loaded speed, or about 31,200 nautical miles. We have not touched upon the economy of operation such as reduced fuel bill, reduced port charges, and absence of stokers, as these have been dealt with in other articles in this journal. The above table gives the foregoing information in a form whereby the difference between the two ships can be seen at a glance:

The difference in the probable average speeds for a year's operation is due to the fact that the speed of the Diesel engines of the motorship is constant, there being practically no propeller racing as with a steamship. A coal-fired steamer would have a lesser average speed because of trimming boilers, slacking of firemen, etc. It will be noticed that while there is a reduction of 6 men in the engine-room there is but a difference of \$1,730.00 per annum in the wages. This is due to better wages being paid to the more-skilled motor engineers.



The Polar-Diesel engine motorship "Svealand" owned by Mr. J. W. Sandegren, of the Rederiakt Svealand of Gothenburg, Sweden

Interesting News and Notes from Everywhere

THE MOTORSHIP "FIONIA"

While at Buenos Aires recently, inflammable material was introduced down the ventilators of the motorship "Fionia" causing an outbreak of fire in her large cargo of hessians, which she was carrying for the British Wheat Commissioner. It occurred shortly before the armistice was signed.

THE JOHNSON LINE OF MOTORSHIPS

The Johnson Line of Diesel-driven motorships has resumed its sailings between Scandinavian ports and the Pacific Coast of North America. The U. S. A. representatives of this important shipping concern are W. R. Grace & Co. Among its numerous large steel ocean going motorships is the "Kronprinsessan Margareta," illustrated in the December 1918 issue of "Motorship."

ANOTHER OIL ENTERPRISE

At Swansea, Wales, a large refinery is to be erected by the Anglo-Persian Oil Company, which is a Royal Dutch Petroleum subsidiary controlled by the British Government. Two million dollars will be spent on wharves, railroads tracks, and equipment. We presume that at this refinery oils from the new Mesopotamia fields will be handled. It is believed that the oil-fields of Mesopotamia will prove of even greater capacity than the Mexican or United States oil-fields. It is said that the transportation of oil from the Persian Gulf to Wales for the most part will be handled by motor tankships.

MOTORSHIP "ANSALDO SAN GIORGIO IV"

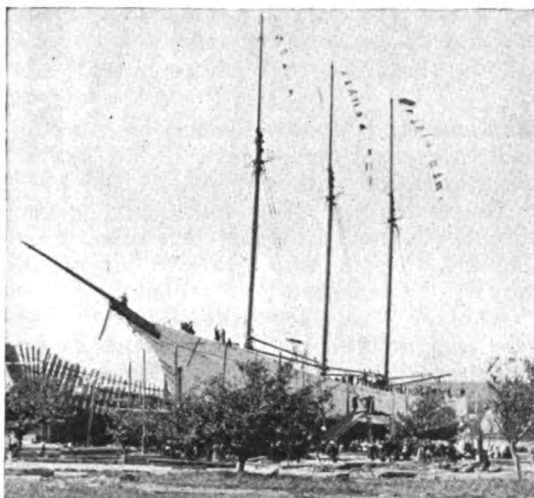
Among large Diesel-driven motorships that soon will visit the United States is the Italian freighter "Ansaldo San Giorgio IV" owned by the Soc. Nazionale di Navigazione, of Genoa, a new steel vessel of 5,600 tons gross (9,000 tons d.w.c. approximately). This is one of the great fleet of motorships built and building at various shipyards of Gio Ansaldo & Co. and Ansaldo San Giorgio, Lt., at Genoa and Spezia respectively. Her length is 380' by 51' breadth and 30' molded depth. She is propelled by two four-cylinder reversible Ansaldo San Giorgio Diesel-engines operating on the two-stroke cycle principle. Her sea speed is 11 knots. The engines of this vessel had a guaranteed fuel-consumption of 0.45 lbs. per B.H.P. hour of high density heavy-oil containing up to 20% pitchy and tarry matters. The lubricating-oil consumption was guaranteed not to exceed 0.017 lb. per B.H.P. hour.

ITALIAN 7,000 TONS WOODEN AND CONCRETE MOTORSHIPS

Now under construction at the new shipyard of the Consorzio Cooperativo per Contruzioni Navali, Pozzano near Castellomere di Stabia, Italy, are four large oil-engined motorships, each of 7,000 tons loaded displacement. These vessels have twin screws and each is to be driven by two 1,000 bhp. Tosi Diesel engines, purchased from Franco Tosi of Legnano, at a cost of about eight million lira. Three of them are of wooden construction, and the fourth is of reinforced-concrete. Sails will be carried as an auxiliary propelling medium. Work on the Diesel engines is far advanced at the Tosi plant. Major-General Antonino Calabretta is responsible for this enterprise, which is being carried out under the sanction of the Ministry of Transports. The structure of the wooden hulls is along absolutely novel lines.

At this shipyard there has been constructed within a short time, a shipway for laying down vessels up to 140 metres in length, whilst other slips are in course of preparation for vessels of 100 metres. In addition, extensive workshops have been erected with electrically-driven saw mills; a complete installation of wood-working machines, fitting shops, and drawing and administrative officers, etc., etc. Provision is also made for the high tension transformation of the electric current (on the Ente-Volturno system) to supply the power for all the machine tools, etc., throughout the establishment.

The Minister of Transport, on the behalf of the General Railway Administration and with a view to encouraging the new enterprise, has accepted the special project submitted by Signor Calabretta for a large Diesel-motor driven ferry-boat to be used on the service of the Straits of Messina, and which will be capable of carrying in one single trip, a complete train of 24 wagons. The principal dimensions of this floating structure—which will be built of wood—are: length overall, 274.5 ft.; beam overall, 46.2 ft.; draught—fully loaded, 29.85 ft.; and displacement, 4,000 tons. This ferry-boat is to be laid down immediately, the building slip being already prepared to receive same.



The 1,000 tons d.w.c. motor auxiliary schooner "Mapleland" building at the Annapolis Royal Shipyard, Nova Scotia, and described on page 25 of "Motorship" for January, 1919.

THE "SANTA MARGHARITA"

The solid-injection "Diesel" driven motorship "Santa Margharita," owned by Sir Thos. Royden, described in a recent issue of "Motorship," was originally the tanker "Olympia" ordered by the British Admiralty.

THE "FAGERLUND"

A Polar two-cycle type Diesel-engine is installed in the "Fagerlund," a vessel of 750 tons gross, built and owned by N. Jakobsen of Norvik, Sweden. She is 175 ft. long, by 30 ft. breadth and 17 ft. depth.

THE ARMSTRONG-WHITWORTH DIESEL ENGINE

Reference has been made in these columns to the marine Diesel engines built by Sir. Wm. Armstrong, Whitworth & Co., of Newcastle-on-Tyne, England, who built the high powered two-cycle type Diesel engines of the motorship "Abelia," which was torpedoed while engaged in naval work in the North Sea.

This well-known engineering concern recently completed their first set of four-cycle type marine Diesel-engine of their own design. In the future they will build both four and two-cycle types of marine motors.

"GUSTAF," A NEW 433 TON AUXILIARY

There has been placed in service during 1918 the motor-vessel "Gustaf," 433 tons gross, owned by the Rederiaktieb Ase of Stockholm, Sweden. She is propelled by a Marstrand oil-engine.

AUSTRALIAN AUXILIARIES

Some of the wooden auxiliaries building at Sydney, N.S.W., for the Australian Government are having oil-engines built by the Clyde Engineering Company.

MARSTRAND OIL ENGINE

Can any of our numerous Scandinavian readers tell us the name and address of the makers of the Marstrand marine oil-engines?

"JUANA," A DIESEL-DRIVEN AUXILIARY

Among wooden auxiliary motorships recently built in Spain is the "Juana," owned by the Artilleres Pasages of Ovio, which is to be propelled by a Werkspoor-Diesel oil-engine.

NEW SWEDISH TRAINING SHIP

The Transatlantic Steamship Co. of Gothenburg, Sweden, owners of 9,500 tons motorship "Bularen," and of 10 sister motorships on order, are about to lay down a four-masted, full-rigged motor-auxiliary training-ship, in order that their future men, engineers, and officers may be properly instructed in seamanship and in Diesel-engine operation. She will be commanded by Capt. R. Bergendahl, who at present commands their training ship "G. D. Kennedy," of Gothenburg.

OIL-ENGINED MYSTERY SHIP SANK THE U-93

It has been revealed by the British Admiralty that it was the 200-ton motor-auxiliary schooner "Prize," ex-German ship "Else" that sank the U-93, which sailed on Friday, April 13th, 1917, from Emden with 18 torpedoes, two 3.9" guns and 37 men. The "Prize" had a concealed naval gun crew and a number of hidden guns, and was under the command of Lieut. W. E. Saunders, who was awarded the much coveted Victoria Cross for bravery under action. The commander of the U-93, Capt. Lieut. E. Freiherr Spiegel von zu Peckelsheim was captured. On this cruise alone he had sunk 11 ships, but the twelfth was the "mystery ship" "Prize" which gave him a little surprise. Unfortunately, a few months later the H.M.S. "Prize" was lost with all hands including Lieut. Saunders, presumably during an engagement with one or more submarines. The "Prize" was a gift to the British Admiralty from Mr. W. Garthwaite, who purchased her at an Admiralty prize court auction sale.

Twenty Advantages of Diesel-Driven Motorships Compared with Steamers

- 1—10% to 12% gain in cargo capacity.
- 2—Very large reduction in fuel bill.
- 3—Reduced constructional cost of ship per ton of cargo carried.
- 4—Absence of stand-by charges in port and greatly reduced port fuel-consumption.
- 5—Greatly increased radius.
- 6—Less frequent bunkering.
- 7—Elimination of unruly-firemen worries.
- 8—Reduced engine-room staff.
- 9—Revolutions of propellers are constant and not dependent upon moods and energies of stokers.
- 10—Propellers do not race in heavy weather.
- 11—Better propulsive efficiency when ship is in ballast.
- 12—Have about 30% special emergency reserve power over normal compared with about 10% to 15% with steam.
- 13—Smaller wage and food bills.
- 14—Always ready for instant start.
- 15—Very rapid maneuvering—full ahead to full astern in 5 seconds.
- 16—Waste exhaust-gases can be used for economically operating part of auxiliaries.
- 17—Dispensation of steam-piping on deck.
- 18—Better conditions for engineers.
- 19—Better all-year-round propulsion efficiency.
- 20—More rapid handling of cargo, effecting shorter stay in port.

To Shipowners—Cut this out and keep before you

World's Highest Powered Merchant Motorship

The Twin-Screw M.S. "Glenapp" a British Diesel-Driven Fast Freighter-Transport of 6,600 I.H.P.

(Exclusive to "Motorship")

ALTHOUGH her shipyards have been more rushed than the shipyards of any other country, and although her shipping emergency has been far greater than that of America during the war, Great Britain has shown the lead in motorship development, inasmuch she completed and placed in service during the most critical period of the submarine menace the highest-powered and swiftest merchant motorship in the world. This, at a time when high speed in merchant-ship construction was vitally important.

We refer to the Diesel-driven vessel "Glenapp," which first was briefly described in our issue of November, 1918, which vessel is said to have a maximum speed of 17 knots, and as she averaged 15 knots on this last voyage from Liverpool, England, to New Orleans, La., U. S. A. (according to Chief-Officer T. F. Ingram) we should not be surprised if she could attain that speed in favorable weather and hold it for short periods.

Her construction round the deck was but roughly finished as she was rushed out of the shipyard to carry troops, for which she was fitted with accommodation for 1,700 soldiers. This, we presume, is the reason why

sand ballast. [Possibly she may have brought back American troops as well, but we have no information to that effect.—Editor.]

The motorship "Glenapp," as her name signifies, is owned by the Glen Line of London & Liverpool, who also own the "Glenamoy"; "Glenartney," "Glengyle," and "Glengary," all large Diesel-driven cargo-carriers, and who are said to have a total of 20 motorships on order in Scottish shipyards. She is one of the many large British motorships constructed through the foresight of that remarkable shipowner and shipbuilder, Lord Pirrie, now Controller-General of Shipbuilding in Great Britain. She has the following dimensions:

Length O. A.	470 ft.
Length B. P.	450 ft. 5 in.
Breadth	55 ft. 8 in.
Depth	36.6 ft.
Accommodation for Troops	1,700 men
Gross-Tonnage	7,263 tons
Net-Tonnage	4,623 tons
Total Officers, Engineers and Crew	67 men
Machinery Staff (Total)	17 men
Propellers	12½ ft. x 12½ ft.
Power (twin-screws)	6,600 I.H.P.
Power per Cylinder	411 I.H.P.
Bore and Stroke	760 mm (29.921 in.) by 1,100 mm (43.307 in.)
Engine-Speed	125 R.P.M.

Unless various and conflicting reports are being given out, it would appear that her cylinders have been made slightly larger than

the "Glenapp" would together develop 5,250 b.h.p. with 920 ft. per minute piston-speed, and with a mean-effective-pressure of 67 lbs. per sq. inch, or a mean-indicated-pressure of 90 lbs. Allowing a mechanical efficiency of 75 per cent., the indicated-horse-power would be 7,000 H.P. Consequently it is probable that in actual fact the "Bullaren's" size of cylinders has been adhered to, or else the speed is from 110 to 115 R.P.M. and not 125 R.P.M. as quoted to our representative.

We have made a few calculations on this basis, as follows:

	"Bullaren"	"Glenapp"
Cylinder Bore	740 mm	760 mm
Cylinder Stroke	1,100 mm	1,100 mm
Engine-Speed	100 R.P.M.	125 R.P.M.
Piston Area	4,300 sq. c/m	4,536 sq. c/m
Piston-Speed	3.67 m/sec = 734 ft. p. min.	4.60 m/sec = 920 ft. p. min.
No. of Cyls. per Engine	Six	Eight
Indicated H. P.	2,000 H.P.	3,500 H.P.
I.H.P. per Cyl.	335 H.P.	435 H.P.
M.I.P.	6.5 Kg. c/m ²	6.25 Kg. c/m ²
Efficiency	0.75%	0.75%
M.E.P.	4.88 Kg. c/m ²	4.68 Kg. c/m ²
B.H.P. per engine	1,500 B.H.P.	2,625 B.H.P.
No. of Engines	Two	Two
B.H.P. Total	3,000 B.H.P.	5,250 B.H.P.
I.H.P. Total	4,000 I.H.P.	7,000 I.H.P.

While the "Glenapp's" engines are of noteworthy power they have not such a great cylinder output as the two-cycle Diesel engines of the Doxford motorships now building, which have a cylinder output of 750 I.H.P., or 3,000 I.H.P. in four-cylinders at 77 revs. per minute.

That the propellers are 12 ft. 6 in. diameter by 12 ft. 6 in. pitch will assist in the calculations. "Motorship's" representative was told that the speed of the "Glenapp" is 14.25 knots light and 13.5 knots loaded. However, we believe she once formed a unit of a 15-knot convoy, so the speed of 15 knots quoted by Chief-Officer Ingram probably is the correct figure. The daily fuel-consumption is 24 tons. The consumption per I.H.P. hour was given as 0.29 lb.

The M.S. "Glenapp" was built for the Glen Line by Barclay Carle & Co., of Whiteinch, Glasgow, Scotland, builders of the motorship "Jutlandia," and is fitted with Burmeister & Wain type four-cycle, direct-reversible, single-acting, Diesel engines constructed by the Harland & Wolff Diesel Engine Works, Lancashire Quay, Glasgow. She carries her fuel and water in double bottoms. She has a shelter, main and 'tween deck.

Her crew consists of 67 officers, engineers and crew, all the latter being Chinese. The engine-crew consists of 8 engineers, 3 electricians, and 6 oilers. For a twin-screw vessel of 6,600 I.H.P., 17 men in the engine-room certainly is a small staff, there being no firemen or trimmers.

The vessel is rigged with four masts, three of them being practically derrick posts for the handling of the cargo. The accommodation below decks has been carried out on most modern lines, there being mess-rooms for officers and engineers, and separate living rooms for each set of four members of the crew. The "Glenapp" is, indeed, a good example of the very marked progress made in this type of vessel; but, unfortunately, we have nothing in the way of merchant freighters in America to compare with her. But it is obvious that the future of America's merchant marine depends upon the rapid construction of a large fleet of similar motorships, and every month's delay is of very great importance.



World's highest powered merchant motorship—the "Glenapp"—at her wharf in New Orleans, La. Her Diesel engines are of the four-cycle type built in Great Britain.

her dead-weight-capacity at present is but 9,600 tons, including 640 tons of fuel and 500 tons of fresh-water for the troops. Because, on her dimensions she easily should be able to carry 11,000 to 12,000 tons of cargo and fuel. The M.S. "Bullaren," a much smaller vessel, carries 9,400 tons of cargo in addition to fuel and water. On this voyage the "Glenapp" will carry freight because it has been found by the British Government that there is a greater need for her as a cargo boat. This is her second trip to America, she having taken one cargo of munitions and cotton from New Orleans to Liverpool, having arrived at the latter port on November 11th, 1918, the day the Armistice was signed. The fresh water space, by the way, eventually will be used for fuel. On the last voyage to New Orleans she only carried 1,500 tons of

those of the engines of the "Bullaren," and her engine-speed increased by 25 revolutions per minute. We estimate that the power developed from 16 cylinders, 760 mm bore by 1,100 mm stroke, at 125 R.P.M. would be 7,000 I.H.P., whereas the M.S. "Bullaren's" engines have 12 cylinders 740 mm bore by 1,100 mm stroke at 100 R.P.M., and each develops 333 I.H.P. for 4,000 I.H.P. for the two engines per ship (6 cylinders per engine).

Our representative was informed that each engine develops 3,200 I.H.P. at 125 R.P.M.; but we previously were informed that on trials 3,300 I.H.P. was produced, so it is quite probable that in the ship the engines are being run at a little below maximum output.

We figure that with 760 mm bore and 1,100 mm stroke at 125 R.P.M. the two engines of

The steering-gear (manufactured by J. Hastie, Greenock, Scotland), is hydraulic operated by a motor controlled by telemotor gear, and the electric-motor for the same is 30 H.P., 114 Amp., 200 V., manufactured by Lawrence Scott, Norwich, England.

The windlass was built by Clark Chapman & Co., and is operated by an electric motor. On deck there are ten 3-ton electrically-driven winches, manufactured by Slkstrom Machine Works, Sweden, and motors by the Allamane Svenska Elektriska Aktie, of Sweden. Size of motors, 80 Amp., 220 V., at 192 R.P.M. There also are two 5-ton winches aft, of same make; motor 21 H.P., 87 Amp., 220 V., also made by the Allamane Svenska Elektriska Aktie, of Sweden. Obviously many American manufacturers are missing excellent opportunities to obtain good electrical business through lack of proper publicity in "Motorship," which is keenly read by the owners and builders of the M.S. "Glenapp."

A point of interest is that each cylinder is a separate casting, whereas in the "Bullaren" they are cast in sets of three. The pistons are of the box type, 18 $\frac{3}{8}$ in. deep, with 8 rings (no two the same thickness) in each. They are water-cooled by means of telescopic pipes, with a tray to catch the water from the glands. (Crew were replacing a cracked piston with a spare, when our representative was on board. The reason of the crack was not given, but probably was due to faulty war-time materials. The cylinder-head studs are 3 $\frac{1}{8}$ in. diam. and are placed as closely together as possible to allow turning of the hexagon nuts.

Piston-rod, 8 15/16 in. diam.

Crank-pins, 14 in. diam.

Propeller-shaft, 15 in. diam.

There is an ordinary marine-type thrust-block with 8 collars. The main engines each are equipped with regular marine Aspinall governors fitted to the fuel-pumps to prevent racing in a seaway. There is a three-stage air-compressor fitted at the forward end of each engine and driven off the crank-shaft.

For forced-feed lubrication, M. & W. A. vacuum oil is used, and for cylinders, Gargoyle D. T. E. Heavy. Both engines use 6 gallons of heavy oil, and 7 $\frac{1}{2}$ gallons light oil per 24 hours, or a total of 13 $\frac{1}{2}$ gallons. Fuel used is 27 to 28 Baume gravity, and is furnished by the Standard Oil Co. The Diesel engines driving the auxiliaries total 660 H.P., consisting of three engines.

All auxiliaries are electrically driven, the power being furnished by 3 D. C. electric generators direct-connected to 320 H.P. Diesel engines. These generators are of 870 Amps., 230 volts at 210 R.P.M. The engines were built by Harland & Wolff, and the generators by Allamane Svenska Elektriska Aktie of Sweden.

The auxiliaries consist of:

One Aux. air-compressor, electric motor-driven (295 Amp., 230 volts, built by Allamane Svenska Co., and one small auxiliary air-compressor, steam-driven, steam being furnished by small oil-fired Cochran boiler, which also furnishes steam heat throughout the vessel.

Sanitary pump } 2 electric motors, 10 H.P.,
1 fresh-water pump } 220 V., 50 Amp.
2 circulating-water pumps; 2 electric motors, 220 V.,
70 Amp., 800 R.P.M., 20 H.P.
1 ballast-pump; 1 electric motor, 15 H.P., 220 V.,
58 Amp.
2 bilge-pumps; electric motor, 15 H.P., 220 V.,
58 Amp.
4 lubricating-oil pumps; 2 electric motors, 10 H.P.,
220 V., 39 Amp.

The ballast-pump is used for the fuel-oil service-pump. The majority of the pumps were manufactured by J. H. Carruthers, Engineers, Glasgow. For the turning-gear there are two electric motors, 220 V., 56

Amp., 15 H.P. There are two measuring or settling tanks installed vertically at the forward end of the engine-room, and these are of 3,100 gals. capacity each. Four starting-air tanks are slung horizontally from the deck beams in the engine-room. Pressure in these tanks is 25 atmospheres. Cylinder compression about 600 lbs.

The "Glenapp" is equipped with a machine-shop containing one 12-in. lathe, 1 drill press and 1 grindstone, all electric motor driven. But she has no ice-machine, and is roughly finished around the deck, having been rushed out to carry troops. In an early issue we hope to give much better illustrations of the M.S. "Glenapp," but while at New Orleans four days' raining, fog, stormy weather, also large quantities of floating roots, logs and tree-trunks were factors in preventing the use of a motor-launch to obtain good photographs.

Finally, let us repeat now what we said in November last, namely in the M.S. "Glenapp" there is a distinct moral for American shipowners to bear in mind: The British nation was far harder pressed with war work, shortage of labor, and materials, than was America, yet one of the best known of British shipbuilders managed to construct last year the largest and highest-powered cargo motorship yet built in the world. What can the U. S. A. to-day show in motor-



Bow view of the motorship "Glenapp"

ship or steamship construction that can compare with this latest British creation? What single merchant ship of any type in the entire American mercantile marine—either built or building—could operate (in normal times) on the same route as the M.S. "Glenapp" and carry freight at the same low rates and show a profit? May we not ask why America has no such ship, and are we not right in asking such a question? Undoubtedly we have got to wake up and get busy without further delay, so as not to be saddled with any more uneconomical steamships that we cannot afford to operate.

Writing to "Motorship" in connection with the motorship "Bullaren," Mr. H. H. Raymond, president of the Mallory Steamship Company of New York, and a member of the new committee appointed by the U. S. Shipping Board to advise on the future type of vessel for American merchant marine, says: "Motorships will undoubtedly be the most successful vessel in the future, insofar as economy is concerned. The performance of the BULLAREN, description of which was in the January issue of "Motorship," is most remarkable." Therefore, it is obvious that a sister vessel like the M.S. "Glenapp" even is a more formidable competitor for ocean trade than the "Bullaren." At the same time both the "Glenapp" and "Bullaren" are too high-powered for some trade rates,

on which vessels of about 11 knots will be more economical and more suitable, so all of our motorships must not be so big or of such high power as these. Nevertheless, we need a fleet of motor vessels of the same sizes and speeds as both the "Bullaren" and "Glenapp." Above all, let us not wait any longer, but let American shipowners, shipbuilders and engineers get right on the job.

IMPORTANT TO AMERICAN OIL-ENGINE MANUFACTURERS

Until hostilities ceased the purpose and effort of the U. S. Emergency Fleet Corporation were to produce useful tonnage in the largest possible quantity to keep pace with the growing need of tonnage as our overseas forces increased and to repair the destruction wrought by submarines. With the signing of the armistice, the problem of the Fleet Corporation took on a different aspect, and the question now is, what revisions of type are advisable and what modifications of plan or practice can be undertaken to give the Fleet Corporation's output of ships as high an economic value in world trade as possible.

The Director-General and the other officials of the Fleet Corporation have for many weeks engaged in a thorough examination of the corporation's building plans and have themselves developed some important suggestions. It is to test these proposed alterations of program that a committee has been appointed, as follows:—

Mr. Geo. S. Dearborn,

President,

American-Hawaiian Steamship Co.,
New York City.

Mr. H. H. Raymond,

President,

Mallory Steamship Co.,
New York City.

Mr. J. A. Farrell,

President,

U. S. Steel Corporation,
New York City.

Mr. F. D. M. Strachan,

President,

Strachan Shipping Corp.
New York City.

In addition to the foregoing, Mr. Charles Piez, Director-General of the Emergency Fleet Corporation, and Mr. John H. Rosseter, Director of Operations of the United States Shipping Board, will be ex-officio members of the committee.

"Motorship" is of the opinion that the majority of the above gentlemen are thoroughly convinced that the large foreign motorships which visit our harbors form the ideal and only economic type of cargo-carrier for America's merchant marine. But, "Motorship" urges that the marine oil-engine builders of America immediately get together and from among themselves form a delegation to visit the above committee and demonstrate to the satisfaction of the committee that America can build and operate and has the facilities for building and operating oil-engines equally good or better than those installed in the foreign vessels. Above all, no time should be lost, as instant action is necessary, and it is up to the manufacturers to do this in their own interests. A great "push" and a strong "push" will produce immediate success!

RAPID BRITISH MOTORSHIP CONSTRUCTION

The "War Jasmine," a cargo-vessel of 8,200 tons D.W. has been launched at the Govan ship-building yard of Harland & Wolff, and her machinery was constructed by Harland & Wolff's Diesel Engine Works at Glasgow. From the laying of the keel to the launching the time required was twenty weeks and one day. The "War Jasmine" is sister to the "War Cowslip" recently launched.

NEW TOSI-DIESEL LICENSE IN FRANCE

A report has reached us that the Thompson Houston Company, of Paris, has acquired a constructional license for the Franco-Tosi (Legnano, Italy), marine four-cycle Diesel-type oil-engine, and will build engines for French merchant ships.

NAVAL DIESEL-ENGINE BUILDER TO RESUME WORK ON COMMERCIAL DIESEL ENGINES

We are pleased to be able to advise shipowners that Busch-Sulzer Bros. Diesel Engine Company of St. Louis, Mo., are now enabled to resume work on their standard stationary type Diesel-engines and on their light-weight and commercial marine Diesel-engines. During the war their plant has been entirely devoted to building submarine-type Diesel-engines for the United States Navy, and, of course, the end of the war now enables them to devote part of their plant to engines for merchant ships. Busch-Sulzer Bros. are building the Sulzer Diesel-engines as developed by Sulzer-Freres of Winterthur, Switzerland.

New Danish Wooden Motorship

"Svendborgsund," a Full-powered Diesel-driven Vessel of 1,230 tons Displacement

Among Danish motorships recently completed is the wooden vessel "Svendborgsund," which is noteworthy for the reason that she is fitted with a Holeby-Diesel oil-engine, and it is the Holeby-Diesel engine that is being built at the New Danish Diesel Motorworks, recently established by the East Asiatic Company and the United Steamship Company as a friendly competitor to Burmeister & Wain.

The "Svendborgsund" was built of oak at the yard of T. C. Jorgensen, Island of Thuroe, Denmark, to the highest class of the Bureau Veritas, and has the following dimensions:

Length bp 150 ft.
Breadth 33 ft. 2 in.
Loaded Draught 13 ft. 3 in.
Loaded Displacement 1,230 tons
Dead-Weight-Capacity 700 tons
Power 400 B.H.P.
No. of Cylinders 6
Engine-Speed 210 R.P.M.

She is a single-screw ship and carries some canvas as auxiliary to the motor-power. There are two cargo-holds, with three hatches, each 16 ft. by 11 ft. and these are served by derricks and motor-winch. The engine is direct-reversible, and is installed just aft of amidship.

An auxiliary Diesel engine of 30 B.H.P. at 350 R.P.M., located in the engine-room drives a reserve air-compressor through a friction-clutch. According to the Danish Survey Rules, an emergency air-compressor has to be provided, and

this machine is driven by a 6 B.H.P. surface-ignition kerosene engine, also made at the Holeby plant. This emergency compressor is intended primarily for supplying compressed-air for starting the auxiliary 30 B.H.P. Diesel engine, in case the starting or injection air-bottles should have lost their charges.

The control-station for the main engine is on the starboard side of the engine-room, where two handwheels are arranged at the centre of the engine, with another above them for controlling the starting-air. Two bottles are provided for the injection-air, one of which is held in reserve, these being arranged on the starboard side. Two compressed-air reservoirs of 3 cubic-metres capacity each are provided on the port side for the starting-air, of which the pressure is about 20 atmospheres. Bulk-headed off from the engine-room are two fuel-tanks with a combined capacity of 35 tons, while two cylindrical running tanks, mounted on the bulkhead above the thrust-block, are each capable of holding enough oil for about 12 hours run. Four pumps driven off the main engine are provided on the port side, two being for water and two for lubricating. Of the former one supplies the cooling-water while the other acts as a bilge-pump, but means are provided for making them interchangeable; one is held in reserve, and the other supplies oil to the main-bearings, bottom-ends, crossheads and pistons, the latter being oil-cooled. The fuel-consumption of the engine is said to be about 0.3 lb. per I.H.P. hour. The machinery has been installed under the special survey of the Bureau Veritas.

SAIL TO AUXILIARY POWER

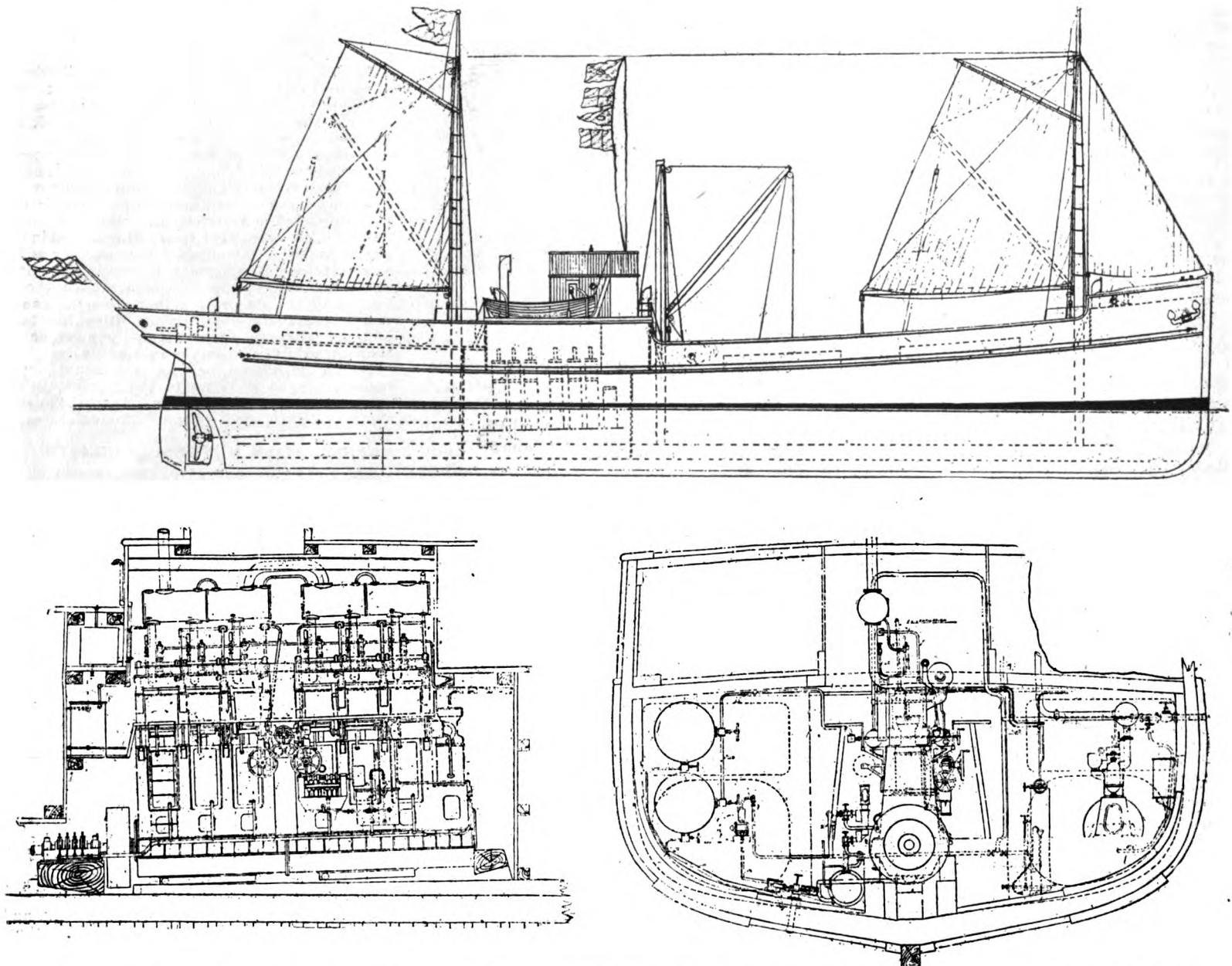
The British sailing vessel "Vonin" has been purchased by Mr. A. B. Fletcher, fitted with an auxiliary oil-engine, and renamed "Arlette."

HEAVY-OIL FUELS FOR MOTORSHIPS

The following oil are fuels that may be used with large Diesel-engined motorships:

Name	Distillation Percentages	Specific gravity	Flashpoint deg. cent.	To 300°	From 300°-350°	Residue
Solar oil	0.88	99	79	17		4
Solar oil	0.857	95	10.4	50		39.6
Solar oil	0.856	92	82	14		4
Mixture Persian liquid fuel and Roumanian distillate	0.897	64	35	46.5		18.5
Solar oil	0.903	105	37	34		29
Solar oil	0.922	130	17	40		43
Solar oil	0.91	152	15	40		47
Residue	0.914	98	48	23		29
Residue	0.95	107	13	46		41
Masout (Batoum)	82	91	7			2
Heavy solar oil	0.913	138	36	57		7
Tarakan oil	0.955	103	41	24		35
Texas oil	0.905	123	30	40		30
California fuel oil	0.962	118	22.5	55.5		22
Egyptian residue	170	10.5	50			39.5
Trinidad crude oil	122	26.0	44.5			29.5
Mexican crude oil	105	26	33			41
Mexican crude oil	0.862	140				67

The above have given good results with Diesel-engines, with the exception of the last which only was used successfully in test-shop experiments under expert supervision. This contained over 2 per cent sulphur and about 67 per cent asphaltum. The list was prepared by Mr. C. Kloos of Amsterdam, who wrote a Diesel-engine paper presented at the International Engineering Congress, all the oils having been tried by engines of his design.



The new Danish wooden motorship "Svendborgsund." She is fitted with a Holeby crosshead-type of reversible four-cycle Diesel engine of 400 b.h.p. On the left is shown her engine, and on the right is the midship section of the ship.

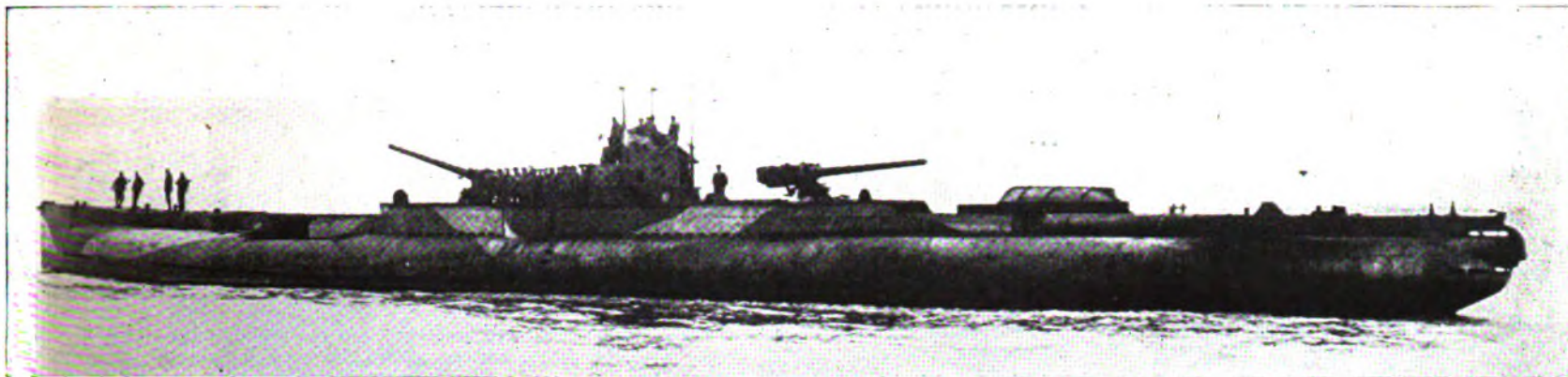


Photo Central News Service, New York

The cargo submarine "Deutschland" converted to a submersible cruiser.

The Cammell Laird Electrically Welded Steel Motorship

Further Details of this Interesting Vessel

Several months ago "Motorship" published an advance announcement concerning the new electrically-welded steel motorship now completing at the yard of Cammell Laird & Co. of Birkenhead, England, to which Sir George Carter, the managing-director, refers on another page. Under his supervision this novel merchant ship is being constructed, also the new type of Diesel oil-engine that is being installed. The vessel is of the coasting type, 150 ft. long and will carry 500 ton dwt. and will have a cargo capacity of 26,000 cubic feet. Her engine is of 500 bhp.

Before the ship was started, a series of tests was instituted in conjunction with Lloyd's Register of Shipping to decide whether welded joints would be satisfactory in a ship. The tests were arranged to obtain information not only on the tensile strength, but also on the elastic properties of welded metal, and its ability to resist alternating stresses. A continuous reversal of stress ruptures a metal at a much lower stress than that at which it fails under a direct pull. In a ship at sea the stress in the structure is constantly changing from tension to compression and back to tension. It was therefore very important to determine the behavior of welded material under these conditions.

The results of the tests showed that if reasonable precautions were taken in the manufacture and working of the welded material, and if certain limits were imposed, the material could be used with success. It should be pointed out that experimental tests, however well devised, cannot take the place of actual experience under working conditions. However, Lloyd's Register of Shipping gave their experimental classification to this process of electric welding, thereby registering a distinct step forward.

The next obvious step was to build a welded ship and test everything out finally. This required faith and courage in spite of the satisfactory tests. Apart from the possible failure of the welded material in practice, there were many things to be thought of. Different joints would be necessary than in a rivetted ship; the problems of assembly and erection were altogether new. Men had to be trained as welders; labor conditions had to be settled; new plants were necessary; and the great war was at its most critical period.

Realizing all these things, Sir George Carter decided that his firm should build a welded ship. Many of the difficulties have already been overcome. All the steel for the vessel is now delivered

to the shipyard; a large quantity has been prepared, and the process of erection and welding-up of the various parts is proceeding rapidly. A considerable weight of material is on the slipway.

Several comparisons have been made between rivetted and welded joints, the latter showing very much better results. This indicates large possibilities. For instance, where transverse and longitudinal girders cross one another, by using a double fillet weld it is possible to maintain 95 or even 100 per cent of the strength of the solid plate across such junctions, whereas with rivetted connections the strength of the girder which is cut is practically reduced to nothing. With such joints, there is no necessity to distinguish between the longitudinal and transverse systems of ship construction, since the full strength can be maintained in both directions. Girders under decks can be fitted entirely between the beams, thereby increasing the head room on passenger decks and the cargo capacity in holds. The principle is capable of extensive application in other advantageous ways.

A very important consideration is naturally cost. It is impossible when carrying out small scale experiments to assess the relative cost of rivetted and welded work. At this early stage in the new method it is difficult to say whether the cost of production will actually be lessened by its adoption. Apart from first cost of the ship, however, there is another consideration. It is possible under several heads to save steel in a welded ship. This not only helps to reduce the first cost, but makes the ship lighter than a rivetted ship.

Messrs. Cammell Laird point out that at the present time there is a big movement amongst Continental and American engineers for the wider application of the oil-engine for marine propulsion, and that it is refreshing to find that at least one purely British firm has been able to perfect an engine of entirely British origin and development with so much success that advantages can be guaranteed which will place it in the very forefront of oil-engine progress.

This promising motor has been developed at their Birkenhead Works, and whilst a full technical description is not yet available, it may be briefly stated to be of the well-known opposed-piston two-cycle type, but marks a great step in advance of any previous attempts made in this direction. A stationary engine of somewhat similar design was described in "Motorship" for November.

The engine embodies all the scientific considerations that go to eliminate the uncertain design factors generally met with in the problem of the large marine two-cycle oil-engine. Thus there are no cylinder covers or scavenging valves. The cylinder liner is a plain open-ended tube that is not restrained in any way and has no large valve openings, and is consequently free from any tendency to develop temperature or stress troubles. The main piston loads are balanced and the bearing reactions are about 50 per cent less than those met with in engines of ordinary designs. The forces on the main working-pins and bearings are reversible eliminating all lubrication troubles so thoroughly that during the extensive experience of running this type of engine, hot bearings of any kind have been completely unknown.

The direct subtraction of the negative from the positive energy of the cycle of operations is claimed to be more directly carried out in this engine than in any other. The work required for producing the scavenging air is directly transferred from the working piston without the intervention of links or cranks. The balance of each unit, and of the engine as a whole, is perfect, and this makes it most suitable for ships where vibration would be undesirable.

From the test results, a guaranteed increase of 50 per cent more power can be obtained over that obtained by other oil-engines occupying the same space. Propeller speeds are also reduced, which is particularly desirable in cargo and other ships to increase propeller efficiency. In nearly every case for equal powers it is possible to give the same revolutions as now adopted for steam engines.

The engine is extremely simple, there being only one valve working per cylinder, and as forced lubrication is adopted the supervision is reduced to a minimum. The balance, low scavenging air-pressure, the distribution of forces and power transferences all combine to give a good mechanical efficiency, resulting in low fuel consumption. It runs quietly, and also possesses the same manoeuvring qualities as the marine steam engine.

In the opinion of far-seeing engineers this engine will at least help to render their engineering establishments independent of German licenses, and it only remains for shipowners to encourage every attempt that is being made on their behalf.

Messrs. Cammell Laird & Co. are offering constructional licenses for this engine to American engineering and shipbuilding companies.



Times Photo Service

One of the many Russian Diesel-engined passenger motorships on the Amur River. They are equipped with Nobel & Kolomna oil-engines of 1,200 total B.H.P.

Performance of the Twin-Screw Motorship "George Washington"

A Trip to the Orient and Return

By HUBERT C. VERHEY

[Engineer-in-Charge. Marine Diesel Engine Dept. U. S. Shipping Board, Emergency Fleet Corporation]

(Published by the Kind Permission of the U. S. Emergency Fleet Corporation)

THE twin-screw motorship, "George Washington," was built and engined by Burmeister & Wain, Copenhagen, Denmark, in the year 1916 for service between Norway and the Pacific Coast, and is owned by the firm Fred-Olsen, of Christiania, Norway. The ship is classified in Class Lloyd's 100-A-1 Shade Deck. Her capacity is 9,400 tons D.W. Signal letters M P H V.

The propelling installation consists of two 4 cycle, single acting, 6 cylinder, direct-reversible Diesel engines, 24 $\frac{1}{8}$ in. bore by 37 $\frac{1}{8}$ in. stroke at 125 R.P.M., developing 1,550 I.H.P. per engine. The contract speed of the vessel is 11.15 nautical miles per hour for total 3,100 I.H.P.

Chartered by the U. S. Shipping Board for a trip to the Orient and return, the loading of the vessel was commenced on December 3, 1917, and finished December 18th. 5,330 tons of cargo were taken on for Kobe, Japan, and 2,970 tons for Manila, P. I., while in addition approximately 1,000 tons of fuel-oil were carried, making a total of 9,300 tons. The largest part of this cargo was steel in the shape of billets, bars, and plates, while the rest consisted of machinery, automobiles, cotton, and general merchandise.

The vessel left Pier No. 32 at San Francisco, California, at 2:15 p. m., on December, 19th, in command of Captain Erik Thomle, and with the Shipping Board representative on board, arriving successfully in Kobe the 16th of January, where anchors were dropped at 2:15 a. m. A south-westerly course was steered towards the Hawaiian Islands, in accordance with the desire of our San Francisco officials, and was changed to approximately west when 23 degrees latitude was reached, and changed to a N. W. course from Marcus Islands on to Japan. On the return trip

a northeasterly course was steered practically following the great circle route between San Francisco and Yokohama, as shown on charts.

On the last named date, at 10:00 a. m., anchors were lifted again and dropped at 12:40 p. m., after various manoeuvres, and the unloading of the cargo into lighters along side of the ship commenced at 1:00 p. m. that day. SIX THOUSAND THREE HUNDRED AND THIRTY miles were traveled in 26 days and 5 $\frac{1}{2}$ hours (change of time included) thus averaging 10.05 nautical miles per hour. The maximum nautical mileage per hour reached was 11.7 and minimum 4.82 during this trip, depending on weather conditions.

The vessel was loaded to her summer mark, and registered a draft of 26 ft. 4 $\frac{1}{2}$ in. forward and 26 ft. 6 in. aft. This draft was reduced to 25 ft. 3 $\frac{1}{2}$ in. forward and 26 ft. 3 $\frac{1}{2}$ in. aft on arrival in Japan on account of the fuel-oil consumed during this trip, showing that most of the oil was taken from the forward tanks. The before mentioned cargo proved to be a very difficult one to carry, which was clearly shown during heavy weather encountered.

Nevertheless, the ship was remarkably steady, a great difference was noticed between this kind of cargo and the ones carried on the return trip, and caused damage before reaching Kobe. In fact both railings at the man deck were cracked amidship while also the joints of the upper plates were affected and showed a slight tendency to shear. The construction, however, of this railing was not substantial as the upright angles carrying the boat-deck from the main deck up, were penetrating the horizontal flange of the railing, leaving only very little material and no reinforcements were provided.

Lloyd's Surveyor in Japan passed on the case,

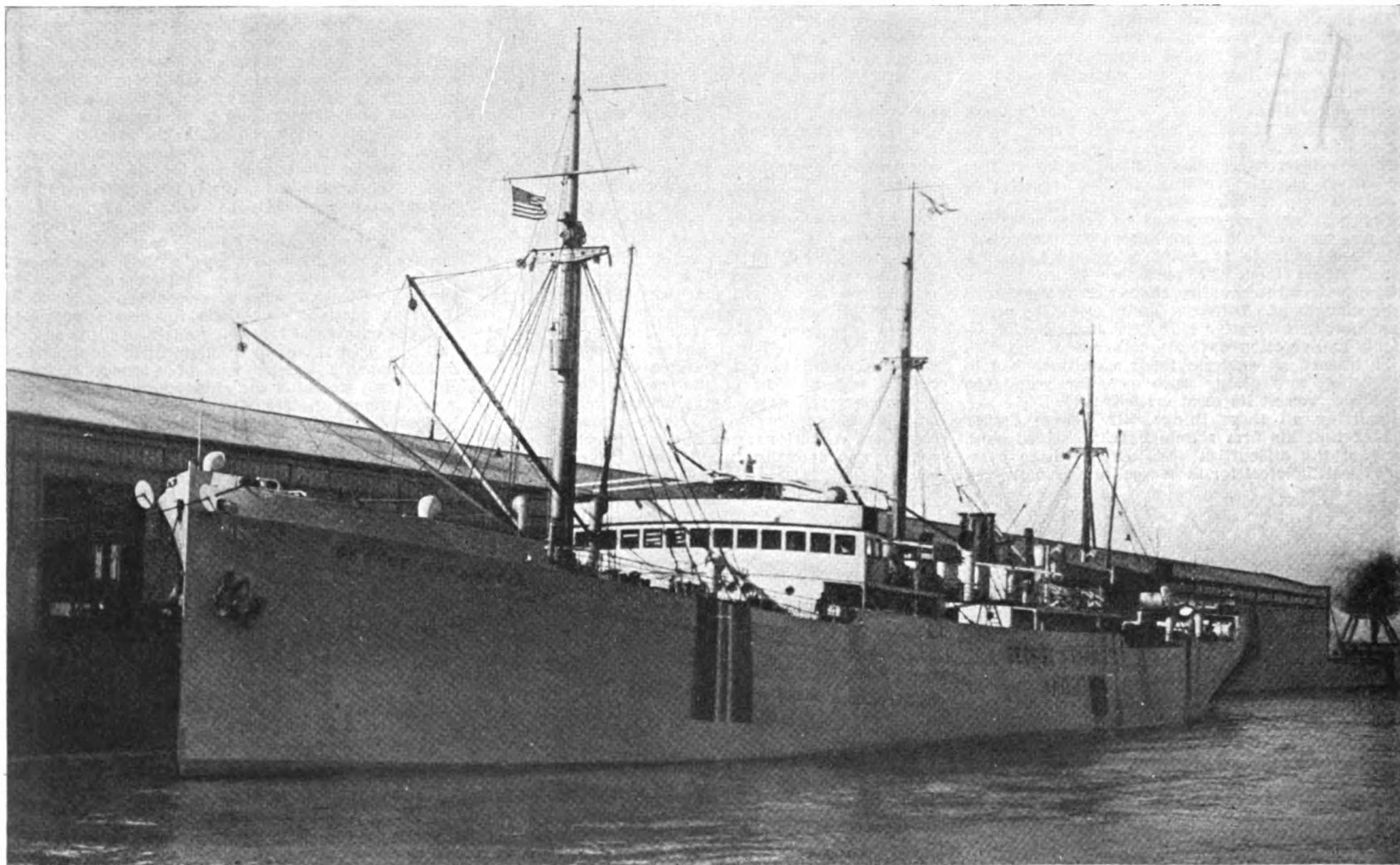
but declared that the damage done was of no dangerous nature so that the return trip could be made without harm and repairs made on return to San Francisco.

During the voyage to Japan, no stop was made with the vessel proper, nevertheless, it was necessary to stop the starboard engine on the second day out on account of a leaking fuel-valve on Cylinder No. 2, as it became necessary to replace this valve due to an unsuitable packing for the fuel needle. This packing was purchased in the United States because the packing originally furnished by the engine-builders ran short and the engineer had to take his chances with the before mentioned result, which is quite excusable, however, in the writer's opinion. It took 30 minutes to replace this valve, during which time the port engine was kept running.

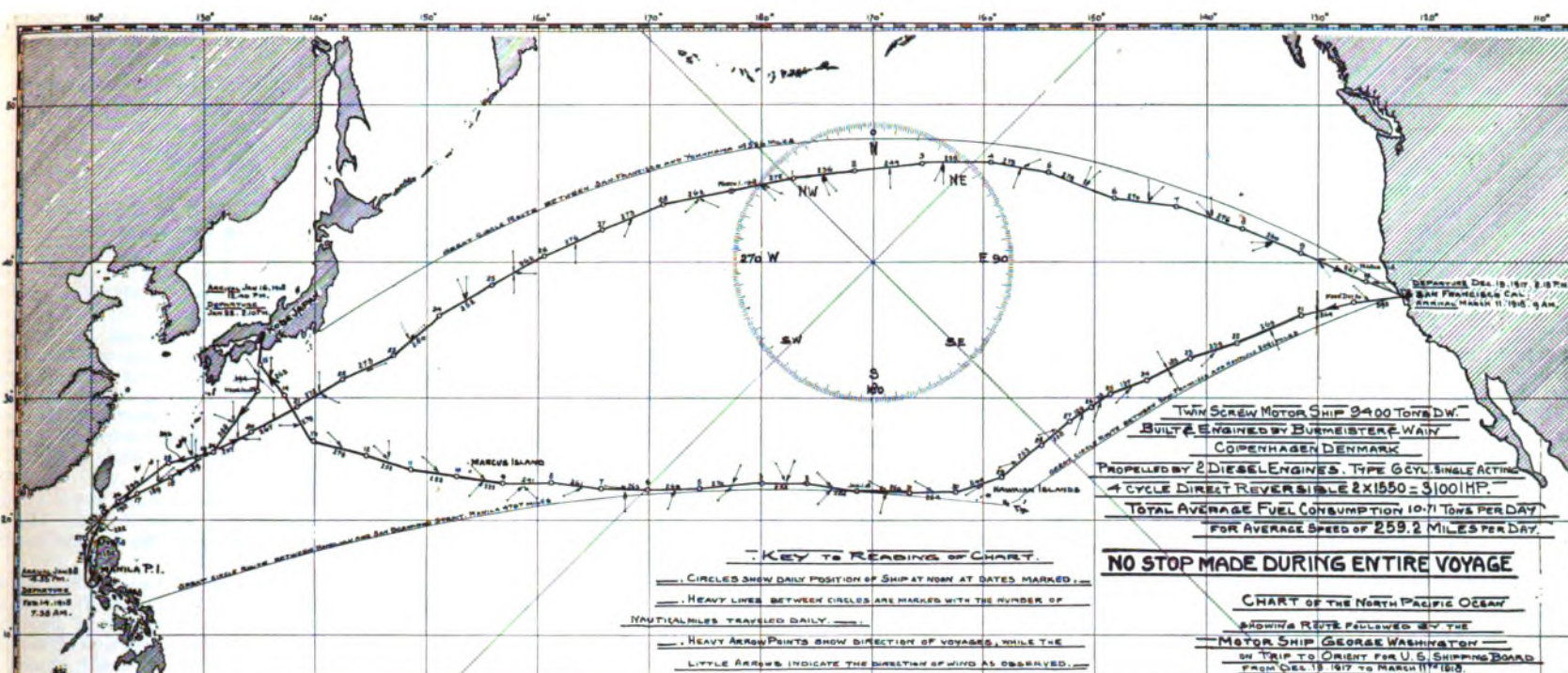
The early part of this voyage was marked by rough weather, gales, heavy swells and much water on deck, so that it was necessary to go at reduced speed from December 25th to December 28th. The tarpaulin of the extreme forward hatch was blown to pieces and had to be replaced.

After the cargo had been discharged, loading was commenced of 1,300 tons of cargo, consisting of general merchandise from Japan to Manila, so that this voyage was started with 4,270 tons in addition to approximately 730 tons of fuel-oil left in the tanks, making a total of 5,000 tons. The draft of the vessel at this load was 15 ft. 0 in. forward and 19 ft. 8 in. aft.

Six days were spent in loading and unloading. On January 22nd, 1918, the anchor was lifted at Kobe, Japan, in order to proceed to Manila, P. I., which destination was reached January 28th where cargo was discharged at Pier No. 3, at 5:00 p. m. This voyage was marked by splendid weather



The Diesel-driven motorship "George Washington"



and a smooth sea, therefore, 1,736 miles were covered in six days and one and one-half hour thus (change of time included) averaging 11.84 nautical miles per hour. The maximum speed per hour observed as 12.4 knots, the minimum 10.22 knots. The draft reduced on arrival was 15 ft. 0 in. forward and 19 ft. 4 in. aft. No trouble whatever was encountered with the ship, or propelling installation.

The unloading of the cargo was accomplished in 8 days after which the ship went for anchor in the bay, and re-loaded in 9 days.

2,115.7 tons of copra were taken on as well as 3,015.8 tons of sugar, and 15,949 bales of hemp, while in addition 2,000 barrels of coconut-oil were carried on deck. Approximately 665 tons of fuel-oil were left over, making the total tonnage of cargo carried about 9,000 tons.

On February 14th, the ship left Manila at 7:35 a.m., and Pier No. 32 at San Francisco was reached at 9:00 a.m., on February 11th, 1918. Six thousand five hundred and forty-six miles were traveled in 23 days, 6½ hours, and the engine worked splendidly at all times.

The average distance traveled per hour was 11.2 nautical miles, the highest observed, 11.53 nautical miles, and the lowest 8.55 nautical miles.

The whole trip was marked by weather in accordance with the time of the year. Strong

winds and heavy swells were met, but the ship appeared to be much better balanced. She did more rolling and less pitching this time, due to the difference in cargo, and the deck-load came over in perfect shape. Much credit is due to the seamanship of the officers and crew, as the ship was kept in perfect trim during the voyage, as the photographs will illustrate.

The total distance covered for the round trip was 14,612 miles, during 55 sailing days and 13½ hours, thus averaging 10.8 miles per hour, the change of time being taken into consideration. During this time, 597 tons of fuel-oil were consumed making an average of 10.74 tons per day, which included the fuel-oil for all auxiliary machinery, and 20 days of firing of the donkey-boilers for heating purposes. The propelling installation alone consumed in total 567 tons averaging 10.2 tons per day.

The main engines show an average record of 0.3 pounds of fuel-oil per I.H.P. hour, which figured with a mechanical-efficiency of 76%, would amount to 0.372 pounds per B.H.P. hour. The lubricating-oil consumed shows an average of 0.0013 lbs. per I.H.P. hour. The relation between fuel-oil and lubricating-oil consumption is approximately 230 to 1. The fuel-oil used had a gravity of 24 degree Beaumé having a heat value of 18,300 B. T. U. per lb.

GENERAL DESCRIPTION OF PROPELLING INSTALLATION

The appearance of the engine-room is extremely neat and practical, as illustrated on the engine-room arrangement drawings.

The main engines are of the four-cycle, single-acting, enclosed frame type, direct-reversible, and together develop a maximum of 3,189.19 I.H.P. at 129 R.P.M. A three-stage air-compressor furnishes the injection-air and is directly driven from the main crankshaft. The auxiliaries are all electric driven for which three 2-cylinder Diesel-engine sets, directly coupled with generators of 60 K.W. are installed on the port side. One of them is constantly engaged to take care of the circulating water and lubricating-oil pumps, and connects to the lighting system.

The last named pumps, two in number, are located alongside of the forward bulkhead. At the starboard side, the following auxiliaries are located and named in rotation, starting from the forward bulkhead:

- 1 drill press } Work-shop.
- 1 lathe
- 1 ice-machine.
- 1 auxiliary air-compressor.
- 1 ballast-pump.
- 2 sanitary and general service pumps.

In addition to these electric-driven items, an electric turning-gear for each main engine is located at the aft bulkhead on the outboard side.

The thrustblocks are located in a recess aft, where also the oil-burning donkey-boiler, serving as heating plant for the ship, is located. This recess offers space for the hand lubricating-oil tanks which are located overhead.

The starting-air tanks are on the starboard side, located above the floor, from the forward bulkhead on, supported from the lower deck. The alley between the main engines is elevated while

the following items are located over there seen from forward to aft:

- 1 Fuel-oil ballast-tank pump.
- 2 Starting-air bottles S. S. engine.
- 1 Desk.
- 2 Mechanical telegraphs.
- 2 Starting-air bottles, Port engine.
- 1 Steam-driven auxiliary compressor.

The rest of the engine-room floor is at one level.

An electric-driven rotary pump serves for daily filling of the 3 fuel-oil service tanks which are located forward at the level of the upper platform.

In front of these service tanks a work-bench with two vises is located. To the right and left, at the aft end of the engine-room at the same level the storerooms are arranged for. The upper platform offers admittance to the engine-room from both the port and starboard sides.

The switchboard is located on the lower platform towards the forward bulkhead. A transformer for reducing the voltage to 110 volts for the electric-light installation is also located at this platform on the S.B. side.

DESCRIPTION IN DETAIL OF PROPELLING INSTALLATION

The MAIN ENGINE BEDPLATE is of cast-iron. Strong bridges support the bearing shells. The crankpits are open underneath; a bolted-on thin steel plate running over the whole length of the engine collects the dripping lubricating oil and returns it to the sumptank.

The CRANKSHAFT is built-up and in 2 pieces with flanges at both ends and in the middle. The last named flanges carry a gear-wheel for the camshaft drive. The forward end takes the crankshaft for the air-compressor. The aft end is reduced to the size of the thrustshaft. The crankwebs are of oval shape. The lubricating-oil enters from the outside, to the bearing shells, from there through the journal and crankweb to the crankpin.



Oscar Mattsson, Chief-Engineer M.S. "George Washington"



Mr. Hubert C. Verhey, the U. S. Emergency Fleet Corporation's representative aboard the M.S. "George Washington"

The BEARING SHELLS are cylindrical and provided with distance pieces. They are white metal lined.

Two bearing caps held down by 4 studs are used for each journal for handling the sake.

The CONNECTING-RODS are of the ordinary marine construction as well as the CROSSHEAD and GUIDES. Lubrication for the slipper and guides comes up through the connecting rod and is then distributed to the crosshead pins and the other rubbing surfaces. The piston-rod has a large flange on top which bolts on to the piston body. The lower end is reduced and provided with thread and nut, thus holding it down in the cross-head body.

The WORKING PISTON is of cast-iron and finished all over on the outside. Nine piston-rings secure tightness, the lower ring serving as an oil wiper. The piston top is concave, and the inside is provided with corrugations. No ribs are used. Salt water cooling is provided for. A telescopic pipe arrangement for in and outlet takes care of the circulation of the cooling agent.

The WORKING CYLINDERS are provided with loose liners and the cylinder bodies are cast in one piece for each three cylinders. The cylinder bodies are held down by TIEBOLTS, running from the top of the cylinder bodies to the bottom of the bearing bridges, and said bodies rest on cast-iron columns, located opposite the main bearings.

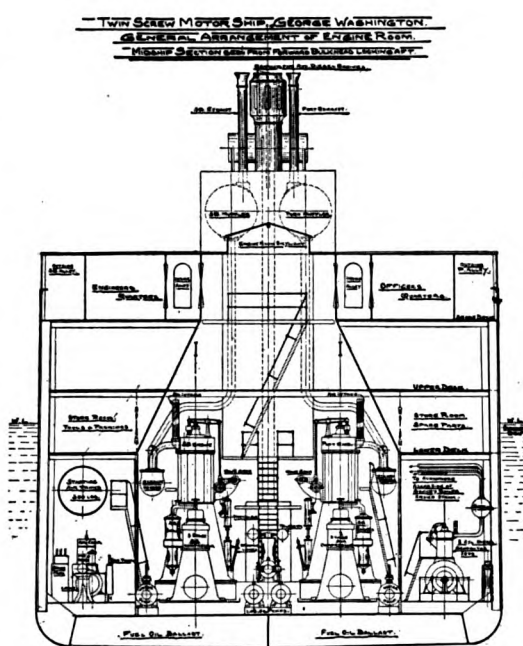
The CYLINDER-HEADS are cast-iron, and are held down by means of 8 studs on the cylinders. A ground tongue and groove secures tightness, while no packing of any kind is used there. Openings are provided for the admission, exhaust, fuel, and starting-air valves.

THE VALVE CAGES are of cast-iron and held in place by studs, while loose valve-seats are provided for. The exhaust-valve cage is water cooled.

The VALVES are provided with loose cast-iron seats; the valve bodies are of steel. Both inlet and exhaust valves are interchangeable.

The FUEL-VALVE is located in the center of the head, and opens downward. It is therefore provided with a seat in the shape of a poppet-valve, thus distributing the fuel-oil and injection-air effectively. Atomizing disks of the ordinary type with small holes are breaking up the pumped-in fuel-oil and mix it thoroughly with the injection-air.

The atomizing process renders very efficient work at the upper end of the working stroke as



Section of Engine-room

the indicator cards (which will be given in the next installment of this report) show.

The STARTING-AIR VALVE is of the ordinary type, and air enters from the side of the cylinder-head. All valves are operated by LEVERS pivoted on a shaft, supported by two steel brackets from the cylinderhead face. The levers are operated by means of vertical PUSHRODS with ROLLERS attached at the lower end in a forked piece.

The CAMSHAFT is provided with a double set of cams, located in succession seen from the front of the engine from left to right as follows: Air-intake, starting-air, fuel-oil, exhaust cams.

A REVERSE SHAFT is provided for and supported in the same brackets as the camshaft. This reversing shaft is composed of a series of little crankshafts. The horizontal position of the reversing shaft outboard engages all rollers and cams for ahead, when turned through an angle of 180 degrees inboard, all rollers and cams for astern are in the proper positions.

During the last named operation, the camshaft is automatically shifted sideways for a length of the center distance of the cams and engages the pushrods for going in either direction.

The MAIN AIR-COMPRESSOR compresses air in three stages from atmospheric pressure to about 36 pounds per square inch in the L. P. stage, to 190 pounds in the second stage, and 850 pounds in the H. P. stage, which air is used for fuel-injection.

The WORKING PISTON is of the echelon type, the wristpin is located in the lower barrel, which barrel acts as a crosshead, taking the normal pressure due to the various crankangles. One of the sketches shows a general arrangement of this compressor.

The AIR-COOLERS are arranged on the outboard side for both engines, and consists of a cylindrical cast-iron barrel, closed at both ends by tube sheets in which brass tubes are expanded, while a connecting piece of cast-iron between coolers takes care of the distribution of cooling water to the compressor body, and to the L.P. cooler.

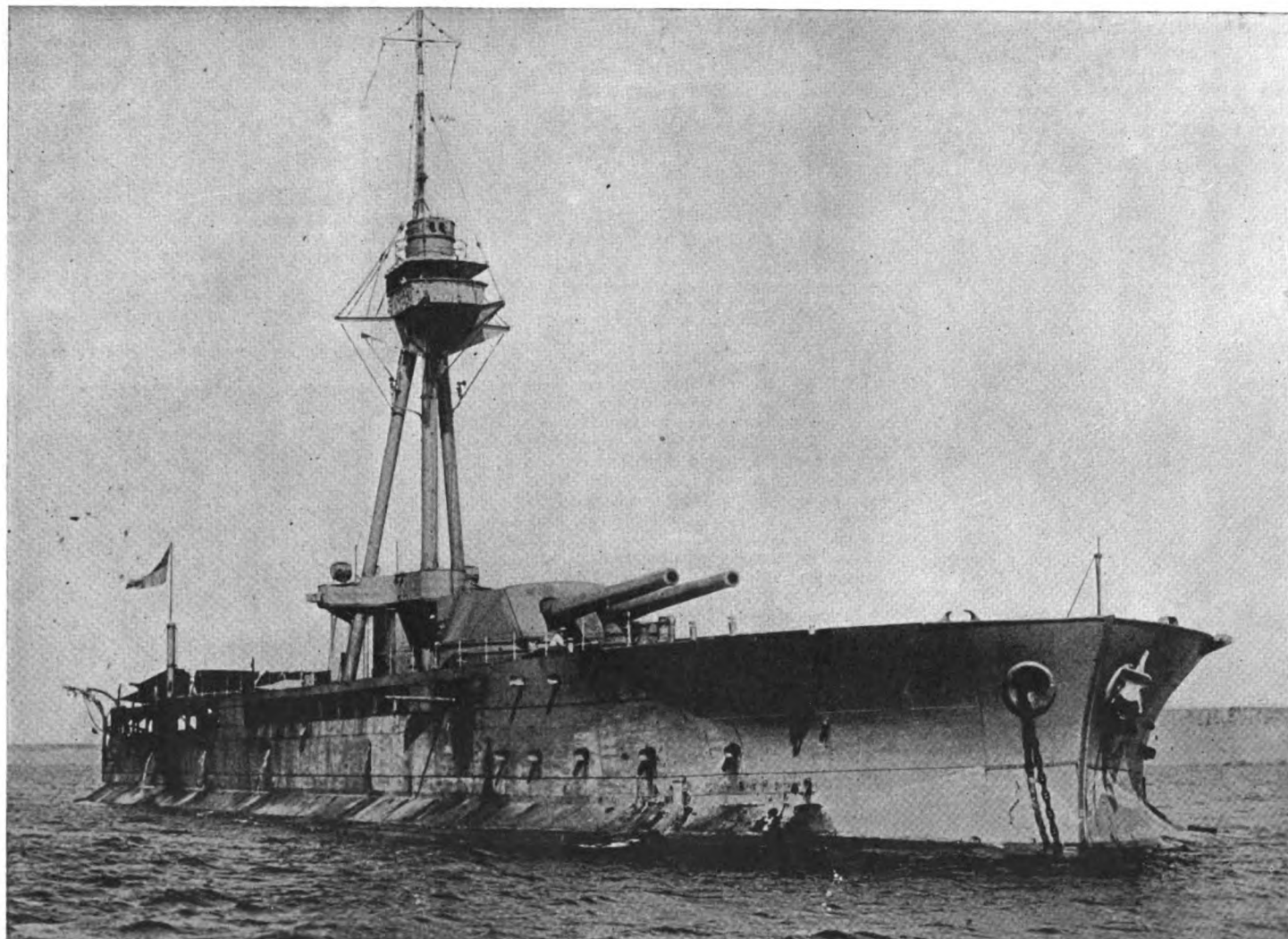
To accomplish this, all the cooling water for one engine is admitted down below in the I.P. air cooler, and follows its way to the engine cooling system.

Due to the relative area of the outlets on top of the I.P. cooler waterhead, and the H. P. water jacket cover, the water is distributed properly, and acts always in opposite direction from the flow of air throughout the compressor, which is the right and most efficient system.

A really valuable feature of this compressor is that the final pressure regulation is not done at the inlet as in most designs; but after the L.P. air has left its cooler, which offers a possibility to drain moisture contained in the air drawn from the atmosphere effectively.

The L. P. stage therefore is designed large enough to offset the loss of volume due to this drainage, as means have been provided to drain constantly, which can be handled from the operating stand, and is controlled by a little valve in the drainline. The slight loss in efficiency of this stage is materially compensated for by the gain in obtaining comparatively dry air, which is of great influence on the lifetime and condition of all valves in the intermediate and high pressure stages.

(To be continued in our next issue)



H.M.S. "Abercombe," said to be a Diesel-driven motor monitor with two 16 in. guns. She is a new type of warship developed during the war, and was one of the British Admiralty's secrets. Italy has similar vessels, and many months ago we saw "Moving Pictures" showing several in action during an attack on an Austrian port.

Fuel-Pumps for Oil-Injection Motors

An Interesting Technical Discussion for Designers

ONE of the most important parts of an oil-engine of the solid-injection fuel-oil type is the fuel pump. This article illustrates method of obtaining the capacity of fuel-injection pumps and does not go into the constructional features. In designing a fuel-injection pump, where one pump is used for each cylinder, it is first necessary to assume the amount of oil expected to be used per horsepower per hour.

One way of considering the problem is to compute actual consumption expected and then multiply this quantity by two and another way is to assume maximum amount of fuel that is expected to be used and then add to this a certain amount, which covers efficiency losses, overload requirements, leakages, etc.

Accompanying this article are three tables. Table I gives the theoretical capacity per stroke of single-acting plunger pumps in cubic inches. So that when the diameter of the plunger is known the stroke may be found for the desired pump capacity. Table II is a tabulated list of comparative values of water and oil. The values for oil are computed for oil having a specific gravity of approximately 0.875. For oil, of different specific gravity, values may be computed very readily. Table III gives the specific gravity of fuels of different weights Baumé.

EXAMPLE I. Assume that it is necessary to design a fuel-pump for a single-cylinder four-cycle engine developing 20 B.H.P. at 330 R. P. M., which should consume 0.5 pound of fuel per horsepower per hour. Fuel pump to be driven at camshaft speed.

20x0.5=10 pounds per hour.

10
—=0.167 pounds per minute.

60
—=165 strokes per minute.

2
167
—=0.00101 pounds per stroke.

31.1=cubic inches per pound of fuel.
31.1x.00101=.0314 cubic inches per stroke.
.0314x2=.0628 cubic inches per stroke.

The above may be written in a formula as follows:

$$Q = \frac{HKR}{60}$$

Q=capacity per stroke of pump.
H=Brake horsepower.
K=cubic inches per pound of fuel.
R=reciprocal of strokes per minute of pump.
Using formula for above example:
$$HKR = 20 \times 31.1 \times \frac{1}{165} = .0628 \text{ cubic inches.}$$

Referring to Table I, we find that any of the following pumps will do:

5/16 diam. by 1/4 stroke has capacity of .0674 cu. in.
3/8 diam. by 1/4 stroke has capacity of .0688 cu. in.
1/2 diam. by 1/4 stroke has capacity of .0735 cu. in.
3/4 diam. by 1/4 stroke has capacity of .0768 cu. in.

EXAMPLE 2. Taking the case of a single-cylinder, four-cycle engine developing 30 B.H.P. at 275 R.P.M., which should consume 0.5 pound of fuel per horsepower per hour. Fuel-pump to operate at camshaft speed.

We desire 0.5 pound per H.P. hour plus, say, 60 per cent extra capacity. The amount delivered to engine will of course be controlled.

Calling pump efficiency 80 per cent we obtain 1.00 pound per H.P. hour as quantity desired.

30x1.00=30 pounds per hour.

30
—=0.5 pounds per minute.

60
275
—=138 strokes per minute (approx.).

2
0.5
—=.00362 pounds per stroke.

31.1x.00362=.1126 cubic inches per stroke.
Writing the above in a formula, we obtain:

$$Q = \frac{HKRq}{60}$$

Q=fuel per H.P. hour desired.
Other symbols same as in previous formula.
Using this formula for above example, we obtain:
$$HKRq = 30 \times 31.1 \times \frac{1}{275} = .1126 \text{ cubic inches.}$$

Referring to Table I we find that the following pumps will do—

7/16 diam. x 1/4 stroke gives .1125 cu. in. capacity.
1/2 diam. x 1/4 stroke gives .1225 cu. in. capacity.
9/16 diam. x 1/4 stroke gives .1240 cu. in. capacity.
5/8 diam. x 1/4 stroke gives .1151 cu. in. capacity.
3/4 diam. x 1/4 stroke gives .1105 cu. in. capacity.

TABLE I

THEORETICAL CAPACITY PER STROKE OF
SINGLE ACTING PLUNGER PUMPS
IN CUBIC INCHES

Diameter Inches	Stroke Inches	Area	Capacity Per Stroke in Cubic Inches							
			1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2
1/16	.425	.049	.0061	.0123	.0184	.0246	.0306	.0367	.0429	.0490
1/8	.4715	.077	.0096	.0193	.0289	.0386	.0481	.0578	.0674	.0770
3/16	.5175	.110	.0138	.0275	.0413	.0550	.0688	.0825	.0963	.1100
1/4	.5635	.150	.0180	.0375	.0563	.0750	.0938	.1125	.1313	.1500
5/16	.6095	.196	.0245	.0490	.0735	.0980	.1225	.1470	.1715	.1960
3/8	.6555	.248	.0310	.0620	.0930	.1240	.1550	.1860	.2170	.2480
7/16	.7015	.307	.0384	.0768	.1151	.1536	.1919	.2303	.2686	.3070
1/2	.7475	.371	.0469	.0938	.1407	.1876	.2345	.2814	.3283	.3752
9/16	.7935	.440	.0563	.1126	.1689	.2252	.2815	.3378	.3941	.4504
5/8	.8395	.515	.0667	.1334	.2001	.2668	.3335	.3999	.4666	.5333
3/4	.8855	.596	.0781	.1563	.2345	.3126	.3907	.4688	.5469	.6250
7/8	.9315	.683	.0906	.1812	.2718	.3624	.4530	.5436	.6342	.7248
1	.9775	.775	.0104	.0208	.0312	.0416	.0520	.0625	.0729	.0833

TABLE II

COMPARATIVE VALUES OF WATER AND OIL

	Water	Oil
1 gal.	.231 cu. in.	.231 cu. in.
1 gal.	.0134 cu. ft.	.0134 cu. ft.
1 gal.	8.33 lbs.	7.30 lbs.
1 gal.	.004165 ton	.00365 ton
1 cu. ft.	7.481 gals.	7.48 gals.
1 cu. ft.	62.4 lbs.	54.6 lbs.
1 cu. ft.	.0312 ton	.0223 ton
1 cu. in.	.0043 gal.	.0043 gal.
1 cu. in.	.0361 lb.	.0316 lb.
1 cu. in.	.00001805 ton	.0000108 ton
1 lb.	.01198 gal.	.01048 gal.
1 lb.	.0016 cu. ft.	.0018 cu. ft.
1 lb.	.2768 cu. in.	.311 cu. in.
1 ton.	240.1 gal.	274.0 gal.
1 ton.	32.05 cu. ft.	36.63 cu. ft.
1 ton.	55402 cu. in.	63291 cu. in.

TABLE III

APPROXIMATE WEIGHT OF OIL

Deg. Baumé	Deg. Specific Gravity	Lbs. per Gal.
10	1.0	8.33
15	.966	8.04
20	.933	7.78
25	.903	7.53
30	.875	7.29
35	.848	7.07
40	.824	6.86
45	.800	6.66
50	.778	6.48
55	.757	6.30
60	.737	6.14
65	.718	5.98
70	.700	5.83
75	.683	5.69
80	.667	5.55

This table is for oil at a temperature of 60°F. When temperature of oil is above 60°F a deduction of 1° should be made on the Baumé scale for each 10°F it is above 60°F.

Add 1° to Baumé scale for each 10°F. temperature of oil it is below 60°F. This is for approximate corrections.

Another method may be used when it is desired to compute the capacity for fuels of different specific gravity. The formula shown below gives the capacity for amount expected to be consumed to which should be added the losses and overload requirements.

EXAMPLE 3. Taking the case of a single-cylinder, four cycle engine developing 20 b.h.p. at 500 r.p.m., which should consume 0.5 pound of fuel per horsepower hour. Fuel pump to operate at camshaft speed. Fuel used to be 30 Baumé, having a specific gravity of 0.875.

$$0.5 \times 20 \times 0.5 = 0.00667 \text{ pounds per stroke.}$$

$$60 \times 250 \times 750 = 0.00667 \times 1728 = 0.211 \text{ cu. in. per stroke of pump.}$$

$$.875 \times 62.4$$

Which may be written in a formula as follows:

$$Q = \frac{C}{H}$$

60 NSx0.0361
C=Fuel to be consumed per b.h.p. hour.
N=One-half of r.p.m.
S=Specific gravity of fuel.
0.0361=Pounds of water per cubic inch.
Other symbols same as before.

When cubic inches per stroke of pump have been computed stroke of pump may be found by dividing cubic inches per stroke by the area of the plunger.

As a formula this would look as follows:

$$L = \frac{Q}{A}$$

L=Stroke of plunger in inches.
Q=Cubic inches per stroke.
A=Area of plunger in square inches.

THE USE OF COAL TAR-OIL AS FUEL FOR DIESEL ENGINES

According to "Gas and Oil Power" of England, the Basingstroke Town Council has adopted a scheme drawn up by their electrical engineer, Mr. G. Broadhurst, providing for the fitting of Smitar's pulverizers to the Diesel engines, by which a considerable economy in crude-oil fuel is expected. Instead of each engine consuming a minimum of 12 lbs. of crude-oil they will be started on crude-oil and, after running five minutes, changed over to tar-oil.

In addition to an annual saving of at least \$1,250 it will be possible to keep the engine running for longer periods; the present ring-type pulverizers have to be cleaned out three times per week, whereas with the new pulverizers this will only be necessary after the engines have run 800 hours, a net saving of 21 hours per week.

The Electric Construction Company has received instructions from the Carnarvon Electricity Committee for the conversion of its Diesel engine to run on tar-oil, at a cost of \$535.00.

NORTH EAST COAST INSTITUTION SCHOLARSHIP

The 1918 Scholarship of the North East Coast Institution of Engineers and Shipbuilders has been awarded to Mr. John Lockwood Taylor, formerly an apprentice in the service of Messrs. Dorman, Long & Co., Ltd., Middlesbrough, England. The Scholarship is one of \$250.00 per annum and is tenable for 2 years.

A prize of \$25.00 has also been awarded to Mr. E. J. Rang who gained second place in the examination.

Two-Cycle Versus Four-Cycle Marine Diesel Engines

An Important Discussion of the Relative Merits of the Rival Types

By GIOVANNI CHIESA, (Engineer and Manager, Turin Works of Ansaldo San Giorgio)

[Readers of "Motorship" will remember a discussion on the above subject in our March, 1918, issue, in which were incorporated the experiences of the noted Italian engineering firm of Franco Tosi with the construction and tests of two and four-cycle type submarine Diesel engines, whereby they abandoned the two-cycle principle for the four-stroke cycle. We publish what obviously is the reply of another great Italian engineering and ship-building company in the "Revista Marittima." Mr. Chiesa's views present the other side of the question, and his contribution comes at a moment when great developments are being planned in this country and abroad. The entire subject is one worthy of being freely discussed by prominent engineers and shipbuilders of the world, and an international convention where many valuable papers could be read on the subject should be held in New York or London in the very near future.—Editor.]

The question of the relative merits of four and two-stroke marine internal-combustion Diesel engines is one of those which is most hotly debated at the present time, both from the theoretical point of view and also on the basis of practical results; it has been, and still is the subject of daily arguments and discussions, of conferences and of articles in trade journals. The object of the present brief study is to co-ordinate the arguments adopted in favor of and against both these types as they present themselves at present in the best designs, and to seek to draw a conclusion therefrom, taking into account as far as possible all the elements of the question.

Advantages of the Two-Stroke Type

The advantages which are attributed to the

This advantage is somewhat diminished by the fact that the two-stroke engine requires scavenging pumps; whereas, in accordance with the arrangement and the mode of working of the said pumps, their weight can be taken as 8 to 12 per cent. of the weight of the cylinders. It results therefrom that the weight of the two-stroke engine will be 62-65 per cent. of that of the four-stroke engine. These figures also appear to be confirmed in practice, although it is difficult to make exact comparisons from the figures communicated by the various builders, as it is not always specified what accessory parts of the plant are included or excluded from the published figures. Side by side with the saving in weight is the saving in space, and on this point the annexed drawings can give a better idea than words; Figs. 1,

stern than the four-stroke engine, so that in this way we not only have a saving in the length of the line shaft, but also an increase in the space available on board for cargo.

Reversing

The two-stroke engine gives greater facility for reversing than the four-stroke engine. This is due to the fact that the two-stroke engine, having ports for the discharge of the burnt gases in the bottom of the cylinder only requires for reversing alteration of the timing of the admission valves for scavenging air, the fuel valve and the starting valves; the change in timing of the scavenging valves may easily be obtained by the simple rotation of the camshaft, as compared with the crankshaft, the change of timing of the fuel valves and starting valves, which only have a small lift, may easily be effected by using double cams sliding on the camshaft.

On the other hand, in the four-stroke engine, it is necessary, in addition to changing the timing of the fuel valves and starting valves, to alter separately the suction and discharge valves; and as these require a different angular movement of the camshaft for each it is not possible to employ the simple devices used in the two-stroke engine, but it is necessary to have recourse to much more complicated mechanism.

From the point of view of starting and reversing, it must also be observed that the necessity of being able to start the engine in any position at which the cranks come to rest, and therefore of having always at least one cylinder in phase for the admission of starting air, does not permit of diminishing the number of cylinders of the four-stroke engine below six, whilst the two-stroke engine can very well be constructed with four cylinders and still maintain perfectly easy working.

Inertia Forces

In the two-stroke engine the inertia of the parts endowed with alternating movements (connecting rods, pistons, etc.) is balanced at the upper dead centre by the pressure on the piston,

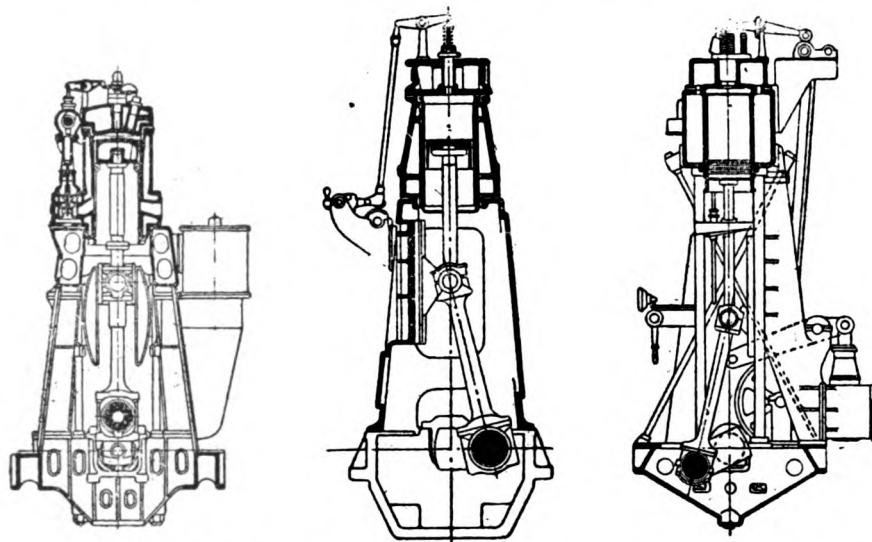


Fig. 1.—From left to right: Two-stroke Fiat San Giorgio engine in M.S. "Ceara," power 2200 B.H.P. at 125 revolutions; four-stroke engine in Burmeister and Wain M.S. "Mississippi," power, 1320 B.H.P. at 110 revolutions; four-stroke Werkspoor engine of 1100 B.H.P. at 125 revolutions.

two-stroke engine over the four-cycle engine, are as follows:

The two-stroke engine develops greater power than the four-stroke engine for the same number and dimensions of cylinders, and with the same number of revolutions. This advantage of the two-stroke engine is due to the fact that in the four-stroke engine there is one impulse for every cylinder for every two revolutions, whilst in the two-stroke engine there is one impulse per revolution; theoretically, the two-stroke engine ought, therefore, other conditions being equal, to have a power double that of the four-stroke engine. In practice, this theoretical limit has not been entirely reached, but at present it may be held that the power of a two-stroke engine is 175-190 per cent of that of a four-stroke engine of equal cylinder capacity; it may be held in fact that whilst the mean effective pressure of the four-stroke engine is about 71 lb. per sq. in., that of the two-stroke engine is practically 63 to 68 lb. per sq. in.

This fundamental advantage of the two-stroke engine carries with it as a consequence a notable saving in space and weight, which can be easily calculated in an approximate manner in the following way:—As there is no reason why a four-stroke cylinder, with its corresponding mechanism, having equal stresses on the materials, should weigh less than a two-stroke cylinder for the same dimensions, and as one can, as shown by the results of experience, consider that the weight is proportional to the volume of the cylinder space, we arrive at the point that, for equal powers and speeds of revolution, the cylinder of the two-stroke engine (taking 175 per cent. as ratio of power of the two-stroke engine, as compared with the four-stroke engine of the same cylinder capacity) has a weight which is 57 per cent. of the four-stroke cylinder.

2, 3 and 4 give a comparison of the two-stroke engines of the ship "Ceara," constructed by F.I.A.T. San Giorgio (now Ansaldo San Giorgio) with the two best-known types of four-stroke engines, viz., Werkspoor, and Burmeister and Wain.

It must be noted that the saving in space of the two-stroke engines also carries with it as a consequence a notable saving in the cost and in the weight of the foundations, a diminution in the dimensions of the engine room and greater facility in the supervision and upkeep of the engines.

Regularity of Torsion

The moment of torsion for the two-stroke engine is, with an equal number of cylinders, much more regular than in the case of the four-stroke engine; figure 5, in which are shown comparative diagrams of the moments of torsion for four-stroke and two-stroke engine with six cylinders and four cylinders, demonstrates the greater regularity of the two-stroke type. The two-stroke engine with four cylinders works out to a notable degree with greater torsional regularity than the four-stroke engine with six cylinders.

This advantage of the two-stroke engine is not purely theoretical, it resolves itself practically into a smaller intensity of vibrations of the stern part of the ship, in a reduction in the dimensions and in the weight of the shaft line, and consequently of all the accessories of same (bearings, stern tube, etc.) According to the rules of Lloyd's Register, it appears that for equal power and revolutions the section of the shaft line of a four-stroke six-cylinder engine must be 45 per cent. greater than the corresponding shaft line of a two-stroke six-cylinder engine, and 11 per cent. greater than four-cylinder two-stroke engine.

It is likewise to be noted that the smaller dimensions of the flywheel of the two-stroke engine make it possible to place the engine nearer the

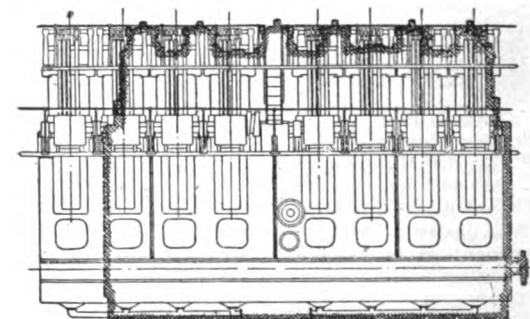


Fig. 2.—Relative space occupied by Burmeister and Wain four-stroke engine of 1050 B.H.P. at 140 revolutions, and two-stroke Fiat San Giorgio engine of 2200 B.H.P. at 125 revolutions in M.S. "Ceara"

which does not occur in the four-stroke engine on the discharge and suction stroke. The consequences of this is that in the four-stroke engine the piston rods are subject to alternate stresses of pressure and tension, the crossheads and the bolts for the bottom ends and main bearings must be made much stronger than in the case of the two-stroke engine in order to avoid the very serious damage which the breaking of the same might cause.

No Exhaust Valves

The two-stroke engine does not require exhaust valves, and for the engines with scavenging ports no valve is subject to the action of the flame; in the four-stroke engine the exhaust valves are a well-known source of trouble, and even when, by means of more or less complicated cooling devices, their maintenance and life are improved, there is always the risk that a valve spindle may break and the valve fall in the inside of the cylinder with grave consequences.

It must also be noted that the exhaust-valves in the four-stroke engine are the parts most sensitive to the quality of the fuel, and that they are very easily damaged by asphalt and by the sulphur contained in the heavy oils of certain origins; the two-stroke engine without exhaust-valves can consequently use certain fuels which are not suitable for four-stroke engines.

Objections Urged by Four-Stroke Advocates

Against these advantages the defenders of the four-cycle engines oppose some objections, partly applicable to all two-stroke motors in general and partly only to special types or special constructional details.

These objections are essentially as follows:—

In support of the four-stroke engines it is asserted that: "Experience with gas engines has led, after a period of favor for two-stroke engines, to giving preference once more to four-stroke engines; for instance, for the two-stroke Diesel engine several failures must be admitted, so that for them also it is advisable to return to the four-stroke type.

Now this objection may be met by the assertion that the example of gas engines is not directly applicable. Two-stroke gas engines, as compared with four-stroke engines, present the disadvantage of a larger consumption and of less easy regulation with small loads. The greater consumption is caused by the fact that a certain quantity of gas is always mixed with the scavenging air, as the two fluids cannot be kept entirely separate and therefore escape, together with the air through the exhaust ports, without producing any work. The bad regulation is due to the difficulty of obtaining the correct mixture with low loads, brought about by the impossibility in the two-stroke engine of regulating the power otherwise than by the impoverishment of the explosive mixture.

Neither of these objections exists with the Diesel engine, the scavenging being done with pure air, while the regulation is carried out in a similar manner for both four-stroke and two-stroke engines. It must also be observed that if, in spite of these considerable disadvantages, two-stroke gas engines continue to be constructed and are at work to the extent of a total power of several hundred thousand h.p., this is a certain proof that the two-stroke engine presents other real advantages in compensation.

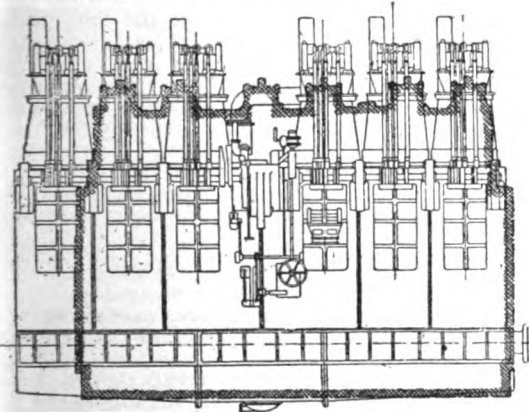


Fig. 3.—Relative space occupied by four-stroke 1320 B.H.P. engine at 110 revolutions, and two-stroke 2200 B.H.P. engine at 125 revolutions.

Rather than cite the example of the gas engine, it would be more just to cite the surface-ignition oil-engine, in which the two-stroke principle reigns almost without a rival, as there are the following types: Bolinder, Skandia, Fairbanks-Morse, Peter, Nat, etc., the four-stroke engines being almost entirely eliminated except for high powers.

With respect to some failures of the two-stroke Diesel engine, it must be noted first of all that these are in great part due to defects in construction; the first engines of the motorship "Sebastien" were replaced by four-stroke engines on account of the inefficient construction of the details of cooling; the engines of the M.S. "Arum" and "Arabis" showed defects in the system of lubrication, while numerous faults were found in the engines which had stepped pistons. Now it is unjust to attribute these failures to the type of engine rather than to the defects in construction and design.

Other failures might be ascribed to builders who, with little or no previous practical experience with two-stroke engines, ventured on the construction of large-powered and high-speed engines.

Scavenging

The two-stroke engine is not easy to design; the scavenging of the cylinders constitutes a very complex problem which cannot be studied experimentally in its details, in spite of the many attempts which have been made up to the present,

and amongst these the experiments made by the firm of Krupp by means of cinematography (moving pictures) with a glass cylinder are especially notable. In scavenging it is necessary that the current of air in the cylinder should displace in a complete and rapid manner the products of combustion without mixing with same; now to project and design in a suitable manner the piping and apparatus for the scavenging and exhaust in such a manner as to get perfect results at a consumption for the air pumps of the minimum amount of power constitutes a problem which can only be solved by lengthy attempts and long and costly experiments.

In case the construction of the cylinder and of the apparatus connected with the scavenging is not suitable, so that the scavenging is imperfect, the working of the engine will prove very defective. Instead of having a cylinder full of pure air for combustion you get an ugly mixture

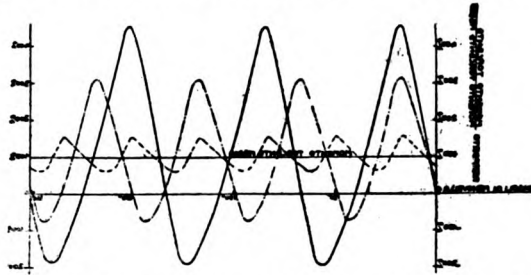


Fig. 5.—Torsion diagram for four-cycle engine with six cylinders; two-cycle engine with four cylinders; two-cycle engine with six cylinders.

of burnt gases not completely expelled, therefore combustion takes place badly and is delayed, the fuel is not fully utilized, and we easily reach at the exhaust a temperature damaging to the maintenance of the cylinders and of the engine itself.

At the present stage of development of the two-stroke engine, constructed by firms which have had the necessary experience, especially of the type with port scavenging, they are not from the point of view of reliability of working in any way inferior to four-stroke engines. Leaving aside for self-evident reasons the engines installed on warships (with respect to this, moreover, the voyage of a Russian submarine from Spezia to Archangel has become known) the successes of the "Monte Penedo" and of the "Ceara", which is the most powerful ship in actual service (the two-cycle Diesel-engined tanker "Maumee" is of higher power, but she is not a complete success and the four-cycle engined ship "Glenapp" is of higher power still.—Editor) are incontestable proofs that the two-stroke engine, when well constructed, can give the best results.

In view of the ample use of internal-combustion engines in the German navy, both of the four and two-stroke type, the fact may be considered worthy of note that the great company Hamburger Werft A.G. (recently founded by the A.E.G. and by the Hamburg-Amerika Line for the construction of motor ships and directed by the late Herr A. Ballin) give the preference to the two-stroke rather than to the four-stroke engine for naval service.

For high-speed engines in 1913, on the occasion of a competition for the German Navy, for electric generating sets of 300 kw., at 400 revolutions in which the greater part of the firm specializing in Diesel engines (M.A.N., Krupp, Koerting, etc.) took part, and the results of which were published in the journal "Der Oelmotor" (Oil Engines), 1913, the consumptions of the four-stroke engines ranged from 0.433 to 0.446 lb. per b.h.p. hour.

Now, not taking into account some isolated figures of excessively low consumptions of four-stroke engines, either due to the circumstances of the tests or to their very high consumption of lubricating-oil, which was evidently in part burnt as fuel, these figures may be regarded as applicable to the best modern practice. From them there results, it is true, a slight advantage in favor of the four-stroke engine, but this does not exceed from 3 to 5 per cent. (This percentage appears to be too low according to the preceding figures.—Ed.), and taking into account the other factors, which must be included in order to calculate the cost of working, no supreme importance can be attached to this difference.

It must, indeed, be noted that the installation in a given type of ship of a two-stroke instead of a four-stroke engine produces, as a consequence of the lower weight and smaller volume, a diminution in the displacement, and the possibility of making the lines of the stern finer, which is equivalent to a reduction of the power necessary for the propulsion at a given speed. This compensates in part for the disadvantage of a slightly greater consumption, such being the case especially for high-speed ships, in which the weight and the space occupied by the machinery are of es-

sential influence. It must be noted finally that, where it is not necessary to attach importance to the weight and to the space occupied, the two-stroke engine can develop the same power as the four-stroke engine at a much lower speed of revolution, and this involves, as a consequence, a diminution in the consumption and a notably higher propeller efficiency.

It is, however, probable that, as in a few years and on the basis of rational and systematic experiments, the consumption of two-stroke engines has been reduced from 0.55 lb. to 0.57 lb. per B.H.P. to the present values, this improvement will be still further accentuated until it reaches, or even passes, the consumption of the four-stroke engine. Theoretically there exists no reason contrary to this, because the thermic efficiency is identical in the two types, and the work absorbed by the air pumps of the two-stroke engine ought not to exceed the work expended in making the driving pistons of the four-stroke engine work for half their time as pumps.

Finally, it is necessary to consider, in addition to the fuel-consumption, the consumption of lubricating-oil, as this is much more costly. It is evident that a two-stroke engine will consume smaller quantities of oil than a four-stroke engine with an equal number of cylinders and equal bore-stroke ratio, as the effort of the piston of the four-stroke engine is about 50 per cent. in excess of that of the two-stroke engines of the same power; and, therefore, the loads on the bearings and on the guides are to a corresponding extent greater, and consequently the areas to be greased are more extensive. Ordinarily, however, the two-stroke engine is constructed with a smaller number of cylinders, and the saving in this case is even more evident. At present the consumption of lubricating oil, in the case of high-speed two-stroke engines (480 revolutions) with oil cooling of the pistons, currently attains the total figure of 0.0067 lb. per B.H.P. hour.

Temperature Problems

In favor of the four stroke engine, it is maintained that: the temperatures assumed by the walls of the cylinders in two-stroke engines are much higher, and therefore, must be subjected to

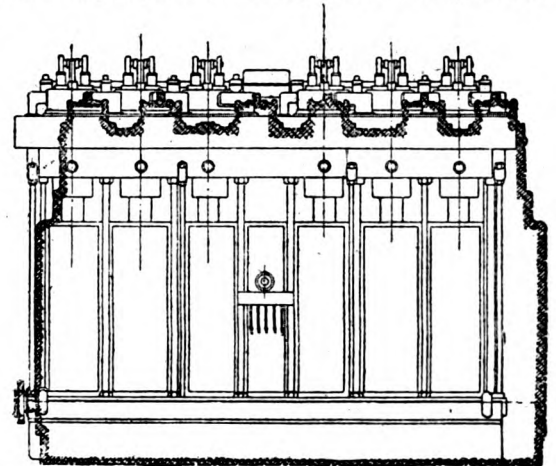


Fig. 4.—Relative space occupied by four-stroke Werkspoor engine of 1100 B.H.P. at 125 revolutions, and two-stroke Fiat San Giorgio 2200 B.H.P. engine in "Ceara."

greater internal stresses, and consequently to damage. Now this assertion is based on the known fact that the ratio between the quantity of fuel burnt in the four-stroke engine and the area of the combustion chamber is little more than half the same ratio for the two-stroke engine; the statement, however, does not take into account the following accessory circumstances, which have a strong influence in modifying the temperatures.

The action of the hot gases in the two-stroke engine is much more rapid than in the four-stroke engine; whilst in the latter the walls of the cylinder are exposed to the hot gases during the whole of the expansion stroke and the whole of the discharge stroke, or practically for more than half the time. On the other hand, in the two-stroke engine the action of the hot gases only lasts for little more than two-thirds of the working stroke.

In two-stroke engines in which the exhaust is effected by means of ports, the opening of these takes place much more rapidly than the opening of exhaust valves in four-stroke engines, and consequently the diminution of temperature, due to expansion, takes place with much greater rapidity.

Whilst the temperature of exhaust in four-stroke engines is rarely below 350 degrees C., and in high-speed engines it easily rises above 450 degrees C. to 500 degrees C., in well-constructed two-stroke engines it is easily maintained below 250 degrees C. and may even be as low as 200 degrees C. to 210 degrees C.

Bearing these facts in mind, a diagram showing the relative temperatures of high-speed four and two-stroke engines has been constructed; this diagram is not of much absolute value, but has a real relative value, being based for the two types of engines on the following similar hypotheses:—

Volumetric efficiency 80 per cent. of the air sucked in at atmospheric pressure and at 15 degrees C.

Adiabatic compression, starting from the temperature of 100 degrees C.

Combustion at constant pressure and adiabatic expansion.

Mean-effective-pressure 71 lb. per sq. in. for the four-stroke engine and 62 lb. per sq. in. for the two-stroke engine (corresponding to the ratio already set forth of 1.75 between the cylinder volumes.)

Fuel consumption 0.435 lb. per B.H.P. for the four-stroke and 0.46 lb. for the two-stroke engine.

For the four-stroke engine, the discharge temperature is supposed to be 450 degrees C., according to the average obtained with the high-speed engines cited above, presented at the competition for the German Navy. For the discharge stroke, the course of the temperature is that obtained practically on the basis of the experiments of Dr. E. B. Wolff (referred to in the journal "Oel-motor," 1915), while for the suction stroke we have assumed a gradual mixing of the products of combustion remaining in the compression chamber with the atmospheric air sucked in.

None of the hypothesis specified above is favorable to the two-stroke engine, and indeed the hypothesis that we have the same initial temperature of compression in the two type is unfavorable to the two-stroke engines, because all the experiments made on gas engines confirm the fact that in two-stroke engines the ratio of compression may be taken as notably higher than in the four-stroke engines, without getting premature ignitions, and that, therefore, the mixture at the beginning of the compression is colder in the two-stroke engine. However, making a planimetric comparison of the two diagrams, we arrive at the conclusion that the average temperature of the two cycles is practically the same.

This result is confirmed by the measurements of the quantities of heat absorbed by the water of circulation in two-stroke engines and four-stroke engines; whilst in the slow four-stroke type, not provided with piston cooling, the quantity of heat abstracted from the cylinders by the cooling water is ordinarily between 580 and 650 calories per B.H.P. per hour, and for the high-speed engines with cooling of the pistons it works out at 800 to 850 calories (these figures were observed in the four-stroke engines at the competition of the German Navy mentioned above). In the stroke engines of suitable construction we get for slow engines 400 to 450 calories, and for high-speed engines 500 to 550 calories.

BATTLE ROYAL BETWEEN RIVAL TYPES

(From "The Motorship and Motorboat" of England.)

The writer does not for one moment wish to make it appear as his contention that the two-stroke engine is destined to replace the four-stroke. But it is evident that there will be a battle royal between the manufacturers of the two types, which is all to the good for the rapid development of the motorship. And it is a matter of special interest in this connection that whilst at the present moment there are something over half-a-million tons of shipping on order in which two-stroke motors are being fitted, approximately the same amount of tonnage has been contracted for, with four-stroke engines as the propelling power. This is, of course, quite exclusive of the submarines and other vessels being built for naval purposes, and also takes no account of the auxiliaries and intermediate full-powered motorships on order in America, which probably total another 300,000 tons deadweight, mostly with four-stroke plant of under 1000 b.h.p. per ship.

It would thus appear that the next two or three years will be momentous in the history of motor shipbuilding, not only on account of the unprecedented output of new craft, but also because of the competition that is now bound to ensue between the two distinctive types of Diesel-engine machinery. And it would therefore be wise for those who are apt to be too ready in their opinion regarding the suitability of one type or another, to suspend their judgment for a short time in anticipation of surprises that may possibly be in store.

THE PASSING OF THE FIREMAN

Whatever difference of opinion may exist as to the advantages of using oil-engines for ship pro-

It is true that, with equal powers, two-stroke cylinders have a surface exposed to the fire of about 20 per cent. less than four-stroke engines, but it must also be noted that the dimensions of the cylinder of the four-stroke engine being greater than in the case of the two-stroke engine, the thickness of the walls are likewise greater, while a great part of the area of the head of the four-stroke engine, on account of the presence of the valves, does not transmit heat.

Taking all these factors into account, we are justified in saying that the two stroke engine,

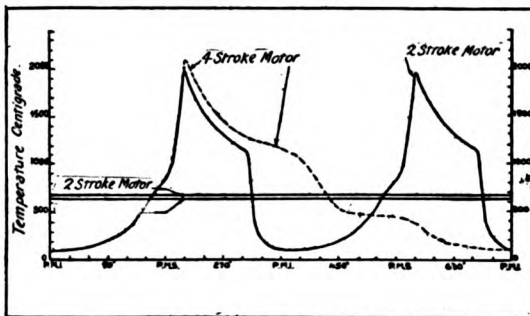


Fig. 6.

from the point of view of temperature, works under better conditions than the four-stroke engine. No doubt, thermically, the two-stroke engine, in which the internal walls of the cylinder, after the very brief action of the flame, are immediately cooled by the current of the scavenging air, blown in in such quantity as to permit not only of the filling of the cylinder, but also of the exit of the hottest gases first, is superior to the four-stroke engine, in which the whole of the heat must be abstracted through the walls of the cylinders with corresponding jumps in temperature of the walls and relative internal stresses.

Unexhausted Burnt Gases

The opponents of the two-stroke engine affirm that, in the cylinders, there easily remain residues of combustion, especially in the upper part, and hence the heads become excessively hot. Now, it must be observed first of all that in the four-stroke engine there remain at least 8 per cent. of burnt gas which fill the compression chamber when the piston has finished its discharge stroke, and this portion of gas cannot fail to become mixed with the air which is drawn in during the suction stroke.

As regards, then, the two-stroke engine, the affirmation that, after scavenging, there remain in the cylinder residues of burnt gases, is only a gratuitous hypothesis, contradicted by the facts already cited, that the quantity of heat absorbed by the walls in the two-stroke engine is less than that in the four-stroke engine, and that in two-stroke gas engines the ratio of compression may

assume greater values than in the four-stroke engines.

In recent careful tests, conducted in the testing rooms of the works of Ansaldo San Giorgio, on a high-speed two-stroke engine of 1300 B.H.P., it was determined that the quantity of CO₂ contained in the gas enclosed in the cylinder during the compression stroke does not exceed three-thousandths, and the content of oxygen was 20.5 per cent. instead of 20.9 per cent., as in pure air, hence the difference is practically negligible.

Flexibility

Against the two-stroke engine it is affirmed that four-stroke engines can work with greater regularity at a low number of revolutions, because in the former the compression at low speed falls very rapidly with the reduction of the pressure of scavenging. Now, this remark is only correct for badly-designed two-stroke engines in which, owing to constructional defects, the scavenging pressure assumes at normal speeds excessively high values; in well-proportioned engines, even at full speed, the air pressure of scavenging is maintained within very low limits; by diminishing the speed, the pressure is likewise somewhat reduced, but not to such an extent as to make the ignition fail, especially when the engine is warm.

Practically speaking, whether in two-or-four-stroke engines the lower limit of the speed is ruled by the design of the atomizer, and the latter in the two-stroke engine is more than sufficient to enable it to be manoeuvred perfectly. It is to be noted, moreover, that in view of the more regular moment of torsion, and taking account the possibility of being able with sufficient regularity to work with half the cylinders, the two-stroke engine has an advantage over the four-stroke engine.

Practically the 1300 h.p. two-stroke engine already cited above, was able to run on the official tests, for a long period of time, at a power of 45 h.p. (i.e., about 1-30), and at the corresponding number of revolutions of 115 per minute.

Conclusions

In conclusion, the two-stroke, when compared with the four-stroke engine, presents advantages in weight, in space occupied, in regularity of the moment of torsion, in facility of reversing, and in the elimination of moving parts subject to the action of the burnt gases, these being important of an incontestable and decisive character. To these advantages the defenders of the four-stroke engine can only oppose observations in part unfounded, in part due not to the system, but to details in the construction of defective engines. On the basis of tests and of practical results of two-stroke engines of good construction, it must be taken that this type will become the standard type for marine Diesel engines, as it already is at the present moment for surface-ignition engines.

Engineer GIOVANNI CHIESA.

pulsion instead of steam-machinery with oil-fired boilers, few will now advocate coal in place of the latter. As is rapidly becoming well known, the use of coal for steam raising, or, in fact, any other purpose, is very wasteful, and we are approaching a time when such abuse of our national resources may be made illegal. Even if enough petroleum becomes obtainable to supply our mercantile marine with fuel, the use of oil derived from coal is a far more efficient proceeding from a national point of view than the burning of coal in its raw state. The old-fashioned fireman and coal trimmers are likely to die out, a development which we imagine even the men themselves will welcome. The work of either is very dirty and arduous, consequently the better class of man devotes his attention to other vocations. The behaviour of firemen has much improved of late years, but at one time those obtainable, particularly for tramp ships, often gave a good deal of trouble to the engineers, coming on board drunk in foreign ports being among the milder transgressions of these gentry. In ships working upon oil-fuel the stoke-hold gang is very much cut down, while the work is of an easy and clean character. Conse-

quently, a better class of man is willing to sign on as a fireman of an oil-fired steamship. Coal trimmers, of course, are no longer needed, as the oil is pumped from the bunkers into the running tanks.

Even these improvements, great though they be, are entirely eclipsed by the arrangements in motorships, where boilers are not required, together with the men for attending to them. Sooner or later, steam machinery for cargo and tank ship propulsion is bound to be done away with, but in the meantime we should imagine that many existing steamships will be fitted with oil burners, either until such time as oil-engines can be obtained for them, or until the ships themselves are worn out or have become obsolete. Incidentally, in connection with the above considerations, an irrefutable argument in favor of the motorship is the fact that owners are finding that it pays them to change over from coal to oil fuel. When one remembers that oil-engines use less than a third of the oil consumed under burners for steam machinery, giving equal power, the overwhelming advantages of the former cannot be gainsaid.

BOUND VOLUME OF "MOTORSHIP & MOTORBOAT"

We have for disposal an extra copy of the bound volume No. 26 of the British "Motorship & Motorboat" for January to June, 1917. The same is brand-new, having just arrived from England after having been held up by the Censor, although a duplicate reached us safely months ago. Also, the British censor's departments seems to have displayed a similar lack of judgment in holding back the copies of the new edition "Marine Oil-Engine Handbook," which we now offer for sale. Nothing in the same could be of military or naval value to Germany. The bound volume of "Motorship & Motorboat," referred to above, can be obtained from the New York office of "Motorship" for \$2.50, including postage.



A general passenger and towboat equipped with a 50 B.H.P. Union motor. She is named "Peterson 16" and is 42 ft. long.

U. S. War Department's Motor-Vessel "Manteo"

Excellent 1993 Mile Run Made by Diesel-Drive Boat at 9:02 Miles Average Speed

IN SEVERAL previous issues we have referred to the keen interest displayed in the marine heavy-oil engine by the U. S. War Department and how in the near future many Diesel-driven ships are likely to be built by the Embarkation Service of the Quartermaster's Corps. In fact, our September issue gave some details concerning 24 concrete and wooden motorships ordered by this farsighted and enterprising department.

The first Diesel-driven vessel built by the U. S. War Department was the "Manteo," a little 100-h.p. boat placed in service of the Engineers' Corps about six months ago, and is used in harbor and river improvement work on the coast of North

On May 31, 1918, the "Manteo" left Erie bound for New Bern, N. C., via the Erie Canal and Hudson River. Its log is as follows:

May 31, 1918—Erie, Pa., to Buffalo, N. Y.; 10:15 hours, 80 miles.

June 1, 1918—Buffalo to Tonawanda, N. Y., Lockport, N. Y., and Rochester, N. Y.; 13 hours, 82 miles.

June 2, 1918—Rochester to Baldwinsville, N. Y.; 10:30 hours, 87 miles.

June 3, 1918—Baldwinsville, N. Y., to Little Falls, N. Y.; 11:15 hours, 77 miles.

June 4, 1918—Little Falls to Troy, N. Y., and thence to Albany, N. Y.; 12:30 hours, 91 miles.

per hour or 0.727 gallons per mile. The average speed through canals and all was 9.02 miles.

The engine is unique in that together with the Sterling and Wisconsin two-cycle type motors it is the smallest Diesel-type engine built of entirely American design and workmanship. The air-compressor is mounted on the crank-case and driven off the main engine shaft; it is of the two-stage type; a surplus of air is compressed and this surplus is stored in two steel bottles and used for starting; a smaller bottle contains the injection air which is held at a pressure of about 1000 pounds per square inch. Reversing is arranged by a Paragon reverse gear. It will be noted that the flywheel is at the after end rather than at the forward end. The operator standing by the reverse-gear and flywheel can control the fuel oil to any cylinder. Each cylinder has its own fuel-oil pump.

AN ECONOMICAL TUG Details of a Successful American-Diesel Installation

In the spring of 1916 a marine oil-engine installation was made in Cuba, which is of special interest because of the noteworthy fuel economy which was obtained, and also the fact that this was the first marine Diesel engine, at least of American design, installed in Cuba. The boat "Juba," as she is named, is owned by the Atlantic Fruit Co., 61 Broadway, New York, and is operated by them at Sama, Cuba. She is used for towing a 60-ton banana barge in the vicinity of Sama, and visits the small harbors thereabouts, taking on loads of bananas, as many sometimes as 7000 stems, and transferring these to Sama, where they are loaded onto the ocean steamers and taken to New York. All the towing, excepting when going into the harbors, is in the open sea, sometimes almost out of sight of land. This is dangerous work, because the ocean at that point has a tide rip of from 7 to 8 miles. During the banana season the approximate distance traveled per week is 400 miles.

The hull is built of Cuban mahogany, which is very hard, and which is plentiful at that point. The stems and knees are natural elbows of the wood. Her length is 55 ft. long, by 12 ft. beam. The engine is a 4-cycle, 70 h.p. oil-engine of the true Diesel-type, operating on low-grade Mexican oil. It was built by the Fulton Manufacturing



U. S. War Department's Diesel-driven boat, the "Manteo"

Carolina, acting as a tender to dredges and used for towing barges, shifting anchors, etc.

The "Manteo" is 52 ft. by 13 ft. and was built by the Chas. P. Wilard Co., Winthrop Harbor, Ill. The engine is a Fulton six-cylinder 8" x 9" oil-engine of the Diesel type, built by the Fulton Manufacturing Company, Erie, Pa. It was shipped from Erie to Winthrop Harbor in July, 1917, but the boat was not finished in time to sail before winter. Before the engine was completely installed the boat suffered an accident and sank. She was raised and towed to Kewaunee, Wis., where she wintered. In the spring she was fitted out and the engine, which had been partly under water, was cleaned and cleared of the water which had soaked into the crank-case. The "Manteo" sailed from Kewaunee on May 16th, 1918, with Captain McDonald, Engineer MacGornto and the engineer from the Fulton Manufacturing Company, H. Y. Jerman, who accompanied the boat only as far as New York.

The log reads as follows:

May 16, 1918—Kewaunee, Wis., to Sturgeon Bay, Wis.; 3 hours, 30 miles.

May 19, 1918—Rough weather and foggy, boat stayed in canal all day; 45 min., 5 miles.

May 20, 1918—Sturgeon Bay to Manistique, Mich.; 9¼ hours, 108 miles.

May 21, 1918—Manistique to Cheboygan, Mich.; 10 hours, 95 miles. On this day the weather was so bad that the engine had to be checked down, the sea was washing over the pilot house.

May 22, 1918—Cheboygan to Alpena, Mich.; 9:30 hours, 100 miles.

May 23, 1918—Alpena to Port Huron, Mich.; 15:15 hours, 160 miles.

May 24, 1918—Port Huron to Detroit, Mich.; 5:30 hours, 60 miles.

May 25, 1918—Detroit to Cleveland, Ohio.; 10:35 hours, 115 miles.

May 26, 1918—Cleveland, Ohio, to Erie, Pa.; 10:54 hours, 108 miles.

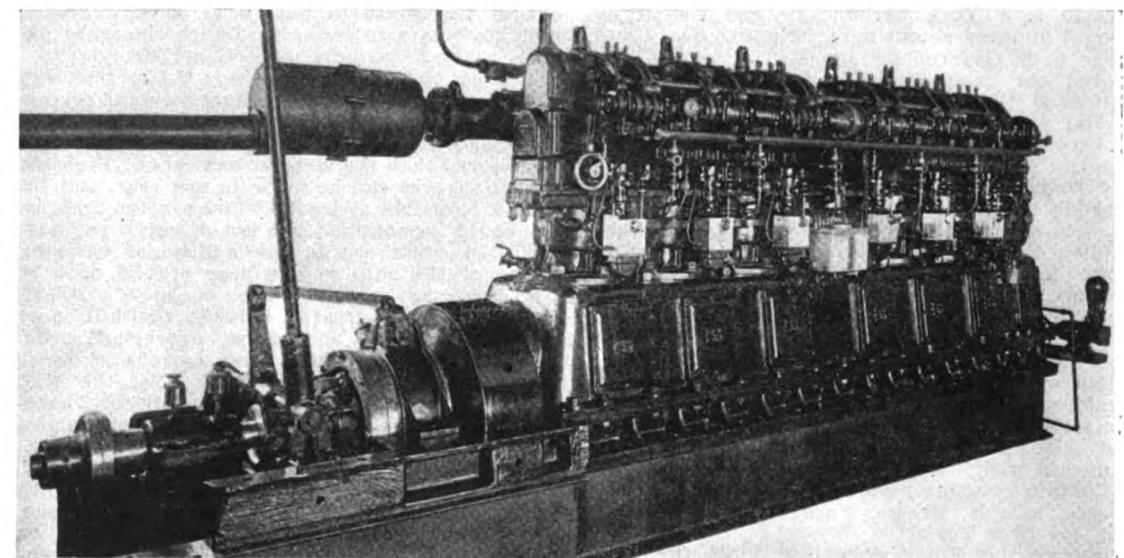
During the above runs kerosene was used for fuel, as the captain was unable to obtain fuel-oil. Only about five hundred gallons were used. The mileage was 781 miles, covered in 74:54 hours, running time. This makes the consumption of oil 6 2/3 gallons per hour. Three gallons of Polarine oil were used and five gallons of 32c oil had been put into the engine base at installation and five gallons during the run; much of this still remained good.

The "Manteo" followed the regular steamer course, out of sight of land much of the time.

On May 30, 1918, the "Manteo" took a run around Erie, 1:30 hours, 15 miles.

June 5, 1918—Albany to New York City, no stops; 13:45 hours, 143 miles.

June 6, 1918—New York to Elizabeth City, N. J.; 1:15 hours, 15 miles. Taking on 450 gallons of fuel oil.



The 100 b.h.p. Fulton-Diesel engine of the "Manteo"

June 7, 1918—Elizabeth City to Bordentown, through the Raritan Canal; 12:15 hours, 67 miles.

June 8, 1918—Bordentown to Betterton, Md.; 13 hours, 100 miles.

June 9, 1918—Betterton to North End Dock, Rapahannock River; 14 hours, 145 miles.

June 10, 1918—North End Dock to N. C. Canal; 10 hours, 50 min., 110 miles. Stopping at Norfolk and taking on 279 gallons of fuel oil.

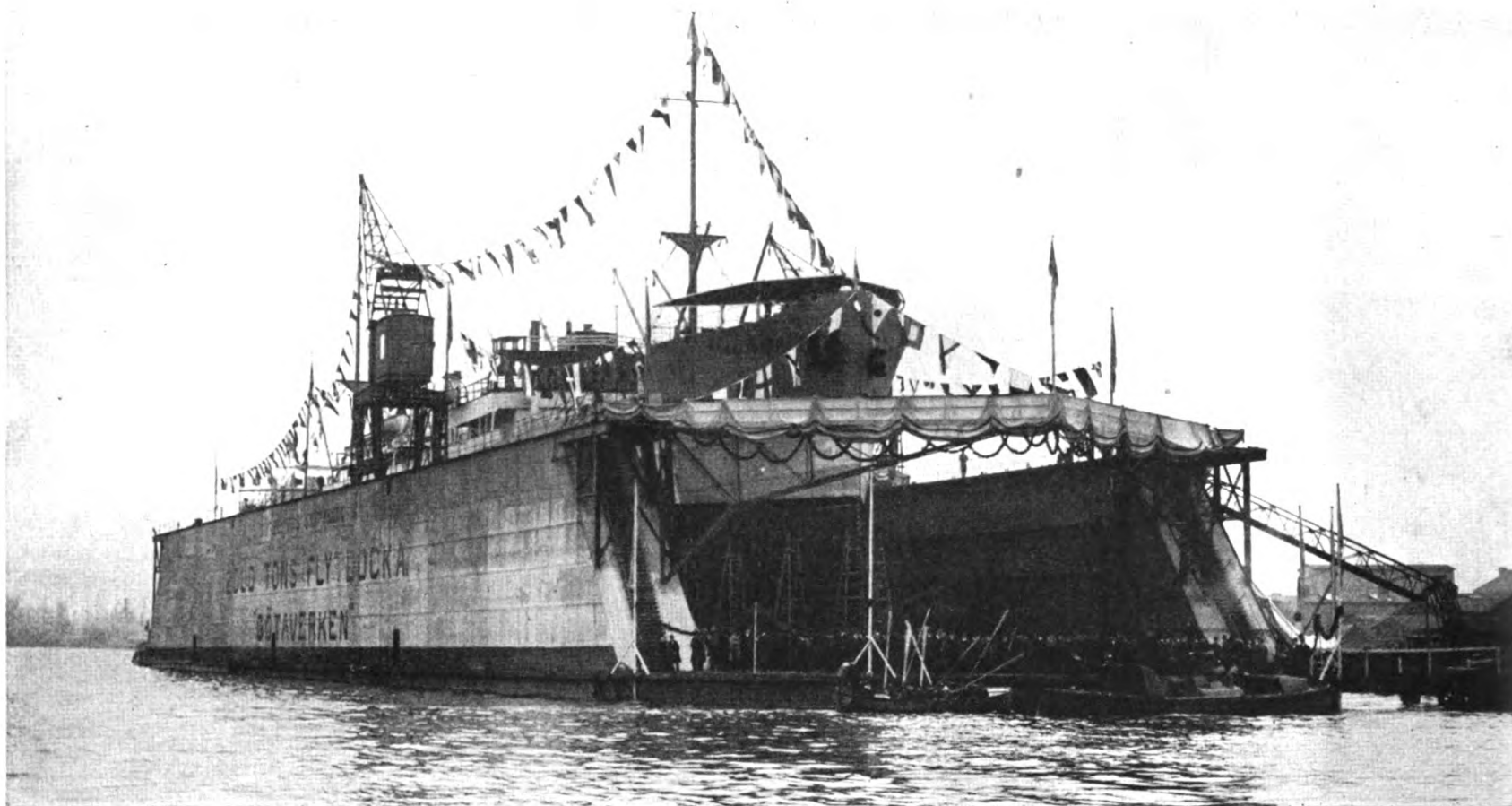
June 11, 1918—N. C. Canal to Adams Creek; 15 hours, 135 miles.

June 12, 1918—Adams Creek to New Bern, N. C. Stopping at Beaufort. 7 hours, 65 miles. Fuel on hand, 350 gallons of oil.

This makes a grand total of 1993 miles from Kewaunee, Wis., to New Bern, N. C., in 221 hours. The total amount of fuel consumed was about 500 gallons of kerosene and 949 gallons of fuel oil. Only about 25 gallons of lubricating oil were used. The average fuel consumption was 6.55 gallons

Co., of Erie, Pa., from their own designs. The two-stage air-compressor is mounted on the forward end of the crank case, driven directly from the main shaft. The flywheel is at the after end. The propeller is a 3-blade 44" x 26" wheel, which the engine turns at 400 r.p.m.

Economy is, of course, the most interesting feature about this or any Diesel engine. The preceding season the Atlantic Fruit Company operated a 40 h.p. gasoline engine, and their fuel bill was \$2,000. The succeeding season the fuel bill for this Fulton Diesel-type oil engine was \$130. Under full-load the engine consumes about 4% gallons of fuel oil, and this at 3c a gallon would cost 13¼c per hour. About three quarts of lubricating oil is sufficient for a 10-hour run. The lubricating oil is forced in a continuous flow on to all the bearings of the crankshaft and up to the wrist pin, and then drips into the bottom of the crankcase, where it is cooled and strained.



The motorship "Bullaren" in the new 12,000-ton floating-dock at the Gota shipyard, Gothenburg.

Further Notes Concerning the M.S. "Bullaren"

New 12,000-Ton Dry Dock, Completed by Her Builders

Fewer articles on motorships have created greater interest than that on the Swedish 13-knot motorship "Bullaren," published in the last issue of this journal. While this vessel was in New York harbor she was visited by several hundred shipowners, Shipping Board and other U. S. Government officials. Everyone who visited her came away most enthusiastic, and convinced that the Diesel-driven motorship of similar size, power, and speed is the main type of cargo-carrying vessel that must be built for America's merchant marine from now onward, and that lost time must be made up with all possible speed.

Since our article on the M.S. "Bullaren" was published we have received a communication from her builders, the Gotaverken (Gota Works), which in-the-main includes the information obtained by ourselves from her officers and crew. Recently this shipyard decided to spend \$1,680,000.00 for further extensions, which will greatly increase their output of motorships and Diesel-type machinery. Very soon the sister ship "Tisnaren" will be in New York, and shipowners desiring to see her should communicate with "Motorship," who will endeavor to obtain visiting-permits from the owners' agents, namely Messrs. Furness, Withy & Co., Ltd., of New York.

It was the Gotaverken that built the M.S. "Hamlet," whose performances were recorded in the November issue of this journal, and in addition have installed oil-engines in several smaller vessels. While working on these craft, the officials of the company gradually came to appreciate the great advantage and possibilities of the Diesel-motor for ship propulsion—we quote the Gotaverken verbatim—and therefore went in for constructing Burmeister & Wain engines on a large scale.

They point out that the "Bullaren's" machinery installation is about 100 tons lighter than the usual steam machinery of similar power, but that the greatest gain is that of deadweight due to the superior fuel-economy. There also is a great saving in fresh-water to which Gotaverken do not refer. This represents about 100 tons in net weight and space.

They say, roughly speaking, the consumption of a motorship like the "Bullaren" is about 13 tons of oil in 24 hours against 55 tons of coal for a steamer. (The "Bullaren" actually uses less than 12½ tons.)

This makes a difference of 420 tons in 10 days; 840 tons in 20 days, or 2,100 tons in a 50 days voyage if made without rebunkering, which would necessitate a steamer going miles out of the route to put in at a coaling-port, with its delays in connecting with clearance papers, coaling, customs inspections, etc.

Let us mention that to this 2,100 tons can be added the 100 tons machinery-weight saving, and about 200 tons of fresh boiler-water in tanks and in the boilers, or a total of 2,500 tons more cargo than the steamer can carry. Probably 5 such voyages can be made in one year, and for such a long trip at least \$60.00 per ton freightage could be obtained per ton of cargo per voyage. In other words the additional carrying power of the ship in one year of 250 days at sea would be represented by about \$750,000.00, apart from the greatly reduced fuel-bill, port stand-by charges and other operating costs, bringing the total gains and savings close to one million dollars per annum. Yet the M.S. "Bullaren" is of only 9,500 tons dwt. Therefore, let us imagine the enormous economies that would be affected by a 15-16 knot Diesel-driven freighter of 15,000 tons dead-weight-capacity, operating say from New York to South Africa, or New York to the Hawaiian Islands, or New York to Australia via South America, or New York to the Dutch East Indies. Such economies quickly would make the fortunate motorship owner a millionaire without taking into consideration the ordinary profits of the ship, which in themselves may be large.

It is well to mention that the better the oil used in a Diesel engine, the less fuel per-power-generated will she use, contrasting with an oil-fired steamer, where the lighter oil will vaporize too quickly and so lose much of its efficiency up the smoke-stack. On the trials of the M.S. "Bullaren" and on her maiden voyage to New York she was forced to use "Water White" refined petroleum, as no heavy-oil was obtainable in Sweden at the time.

Consequently her fuel-consumption on the trial was only 0.126 grammes (0.277 lb.) per indicated horse-power hour, including the auxiliaries. This figures out at 0.37 lb. per shaft horse-power hour, an economy probably never bettered by any vessel afloat, although several motorships have almost equalled this on Solar fuel-oil. The very best oil-fired boiler practice

is 0.90 lb. per indicated horse-power hour, under the most favorable conditions, so the enormous difference at once can be seen. Yet the oil-fired boiler does not maintain its economy with the passing of years of a ship in operation. After motorships have been in service several years their fuel-consumption becomes reduced, and on no account increases. The figures of 0.27 lb. was obtained by the "Bullaren" with her engines new and stiff. The average oil-fired steamer figures at 1.0 lb. per I.H.P. hour. Just think of the tremendous difference when a year's consumption is taken into account. A coal-burner will use 1.5 lb. per I.H.P. hour.

The speed developed on the trial run averaged 12.7 knots with a light load of 2,000 tons corresponding to 6,400 tons displacement. So well did everything go that the ship was accepted by her owners and proceeded straight for New York, without returning to port, arriving there after 15½ days continuous run. Only one motor had to be stopped for 50 minutes in order to change an exhaust-valve spring. Several times she slowed down because of tremendous seas and once to escort a disabled steamship.

She returned to Gothenburg in 15 days with 9,000 tons of oil in cases and barrels and also discharged 400 tons of bunker oil as cargo. On the run to New York the daily consumption of fuel averaged 11.1 tons (or 78 barrels) and 76 kg. of lubricating-oil. On the return to Sweden the fuel-consumption averaged 11.7 tons of fuel-oil and 52 kg. of lubricating oil.

Seeing that she made the return journey in half-a-day less and had 7,400 tons of more cargo and fuel aboard, and was using a heavier oil-fuel, it almost seems as if the engines were more economical than on their trial run.

We understand that the next ship built by the Gotaverken will have quite an innovation, namely, there will be a special device connecting the engine-controls to the bridge, so that if necessary the navigator can stop or reverse the engines without signalling below. While such a device hardly would be desirable, in our estimation, for regular use, we can realize its importance in times of emergency and perhaps a collision one day will be avoided by its use. In our last issue we stated that the electric steering-gear was British built. That is an error, as it was constructed by the Gotaverken.

DOXFORD DIESEL-ENGINEED MOTORSHIPS

Solid-Injection, Opposed-Piston Marine Oil-Engines of 750 I.H.P. per Cylinder at 77 R.P.M. for $11\frac{1}{2}$ Knot Merchant Vessels

Some single-screw $11\frac{1}{2}$ -Knot merchant motorships are reported to be under construction at the shipyard of Wm. Doxford & Co., Ltd., Sunderland, England. The Doxford-Diesel-engines for the same will develop 3,000 I.H.P. in four-cylinders at 77 revolutions per minute, and on a guaranteed fuel-consumption of 0.42 lb. per shaft-H.P.

This means a cylinder output of 750 I.H.P. or the highest yet installed of a marine Diesel-engine, the motorships "Glenapp," "Fiona" and "Bullaren" having a cylinder output of 333 I.H.P., and the motor-tanker "Maumee," 500 I.H.P. per cylinder. Sulzer Bros. have produced 600 I. H. P. from a submarine-engine cylinder, and 790 I.H.P. per cylinder from a stationary Diesel-engine in service. But for marine work the Doxford engine shows a great advantage in power over existing engines in operation. However, "Motorship" will not vouch for the accuracy of the above report.

What will make the Doxford engine of special interest to engineers is that solid-injection of fuel has been adopted. This enables the high-stage air-compressor to be dispensed with.

The design of the engine is such that perfect scavenging is obtained, and a mean-indicated-pressure of 100 lbs. can be maintained, permitting the heaviest oils to be burnt; oils of 0.96 sp. gr. containing 30 to 35 per cent of asphaltic matter already having been satisfactorily dealt with. It is of the opposed-piston type, having been developed from the Junker patents, and a single-cylinder experimental engine built by Doxfords was completely described and illustrated in "Motorship" for 1917.

The "Liverpool Journal of Commerce" has given details of our interesting floating and portable fuel-oil storage tank built by Doxford's during the war, which should be found economical and useful for many harbors and fuel stations, being capable of removal from position to position as circumstances may require for bunkering vessels.

The system adopted in these craft is automatic balanced-pressure in each oil-compartment, the buoyancy space being situated in the upper part of the craft, which forms practically a 'tween decks, and in which is placed the pumping and other gear.

The balance of internal and external pressure is maintained by admitting water by open sea-connections while pumping out the oil, and vice-versa, so that the craft is practically kept at a constant draft and trim, and the hull avoids strains which otherwise arise from full and empty compartments. There is no admixture of the oil and water, this being prevented by the internal arrangements adopted and this test has been very severe, as the operation of pumping in and out has been very frequent in all compartments of the craft.

An important fitting embodied in this system is an electrical indicator in the compartment, which is operated from the pump-room, the apparatus radiating in the tank by hand from the pump-room space, where a register is accurately taken as to the oil level in the compartment, the operating handle being fitted with a calibrated scale, so that the actual measurement of the oil is taken at any moment.

GERMAN CONCRETE MOTORSHIP

An 80-ton concrete motorship has been built in Germany by Ed. Zublin & Co., of Strassburg. The engine installed is of the Polar-Diesel type built by Benz & Co., Mannheim. Two months were required for the construction of this vessel.

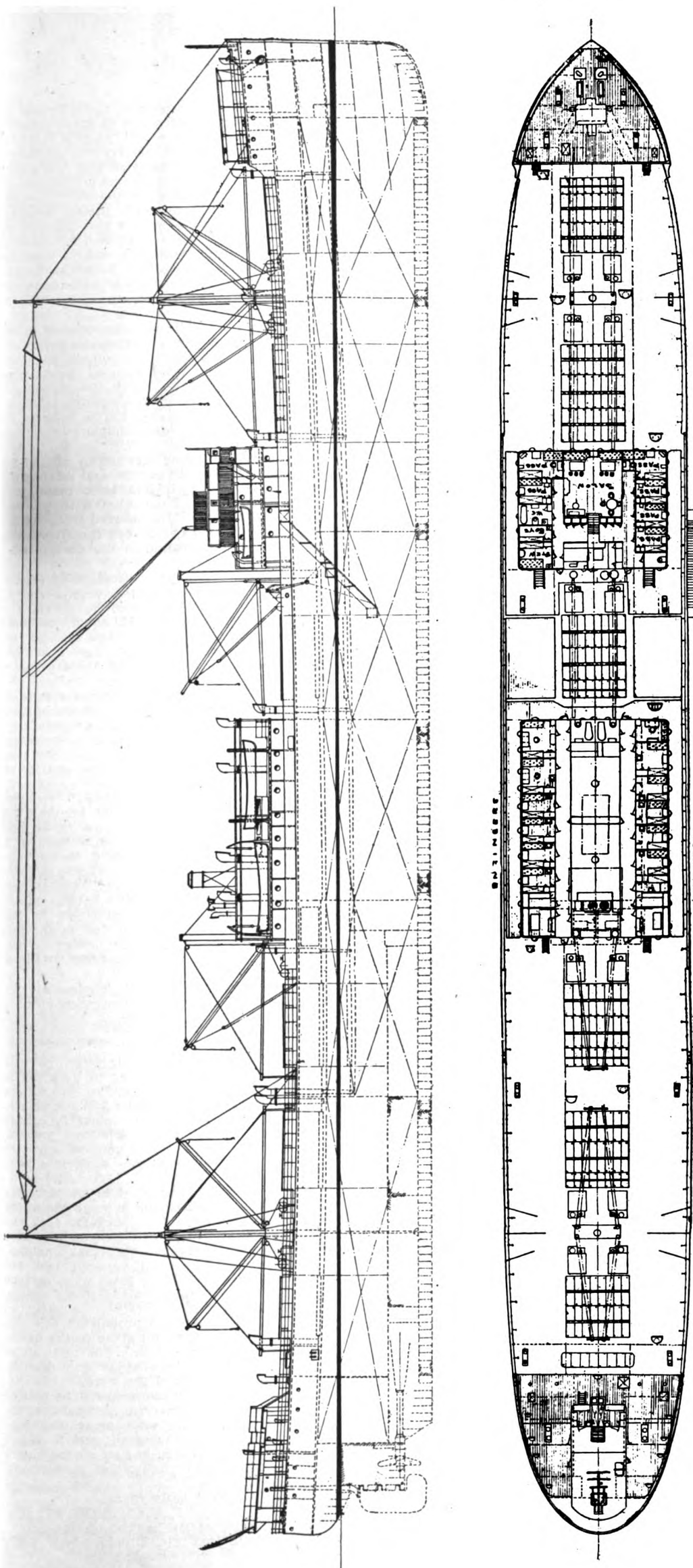
NEW HUNGARIAN COMPANY WITH \$10,000,000 CAPITAL TO BUILD MOTORSHIPS

At Budapest there has just been formed a new company to build motorships and motor auxiliaries, named the Nautika Motorship Works Ltd., with a capital of \$10,000,000. The Pester-Hungarian Commerce Bank is associated with the venture.

THREE AMERICAN MOTORSHIPS FOR FRENCH GOVERNMENT

Readers of "Motorship" may remember the three steel oil-engined motor barges which were operated on the Mississippi by the Inland Navigation Company of St. Louis, Mo. and New Orleans, La. These three vessels have had their small surface-ignition type oil-engines removed, and are being entirely rebuilt by Mr. John H. Bernhard of New York, having been purchased by the French Government. Barge No. 1, will be equipped with two 550 h.p. Winton-Diesel engines, and Nos. 2 & 3 each will be equipped with two 350 hp. Diesel engines.

General-arrangement-profile plan, deck and accommodation plan of the 9,500 tons d.w.c. Diesel-driven motorship "Bullaren."



The "Semi-Diesel" Engine

General Discussion on Mr. James Richardson's Article

At the meeting of the Diesel Engine Users Association on 28th November, 1918, a discussion took place on a paper read at the previous meeting by Mr. James Richardson on "The Semi-Diesel Oil Engine." An abstract of this paper was published in "Motorship" of January, 1919.

Mr. Geo. E. Windeler took exception to the title of Mr. Richardson's paper as he failed to see why the engine particularly referred to was called a "Semi-Diesel" engine. ["Motorship" also drew attention to the same matter.—Editor.] In the mat-

and tear in the parts of the engine. He could not see the reason of Mr. Richardson's statement that the mechanical efficiency of the "Semi-Diesel" was greater than that of the Diesel, particularly as the mechanical efficiency had a fixed ratio to the fuel-consumption which was higher in the case of the "Semi-Diesel" engine. The great advantage of the Diesel engines was its high economy down to half-load and its capacity for burning heavy fuel oils. Flexibility was a difficult problem owing to

Mr. T. C. Thomsen considered the question of clearance with aluminium to be of great importance and he thought that a very viscous lubricating-oil was necessary. He referred to questions of piston construction, lubrication and fuel atomisation, and remarked that he could not understand how the spray could be too fine. He expressed the opinion that much useful research work could still be carried out in the direction of standardization of qualities of fuel-oil for various types of engines, and with this end in view he thought that more co-operation between the engine builders, users, and fuel-oil manufacturers would be useful. [Similar co-operation is urgently needed in this country too.—Editor.]

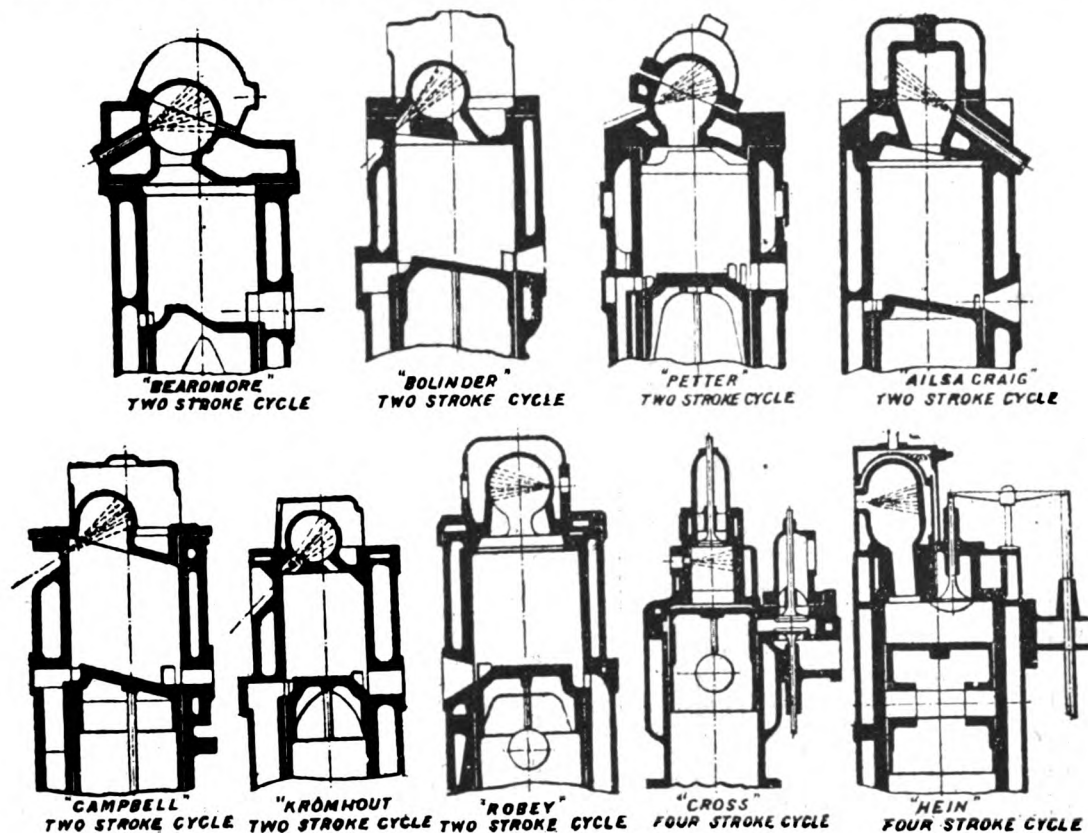
In discussing the merits and demerits of lubricating oil from a paraffin and from an asphaltic-base respectively, Mr. Thomsen pointed out that the use of a suitable lubricating-oil would considerably assist in clearing away the carbon deposit inside the engine due to excessive temperature of the hot-bulb, and he stated reasons in support of his preference for a compound lubricating-oil for such purposes.

Mr. Guy B. Petter looked forward to a great future for the "Semi-Diesel" engine, and referred to the rapid progress which had been made particularly in America in connection with the use of these types of engine. He referred to the small difference in fuel economy between the Diesel and the "Semi-Diesel" engine and to the greater simplicity of the latter type.

Lieut. A. J. Mackay gave particulars of experiments which he had carried out with a special form of cylinderhead with which he obtained a higher mean-effective-pressure. He considered that the spray could certainly be too fine and he had experimented with sprays of all degrees of fineness. He spoke very favorably of his experience with pistons of an aluminium alloy.

Lieut. J. L. Chaloner, R.E., considered that pressure was the governing factor in distinguishing between the Diesel and the "Semi-Diesel" type of engine. He gave some interesting information as to the number of Diesel engines manufactured in this country, and he compared the gravity of fuels used in Diesel and "Semi-Diesel" engines. In the matter of design, the "Semi-Diesel" type was tending towards the Diesel type of engine. He considered the water-injection device to be bad practice and noted that this had now been to a great extent eliminated. In regard to fuel-consumption he thought that to a great extent this was a question of the class of fuel used. He did not agree with Mr. James Richardson's statement that the satisfactory fuel economy attained in the "Semi-Diesel" type of engine was due to the fact that the cycle of operation was nearer to the explosion cycle than to the constant-pressure Diesel cycle.

It was announced that Mr. Richardson's reply to the discussion would be communicated at a later date.



Sections of some of the leading British and European surface-ignition marine oil-engines illustrating Mr. James Richardson's article given in our last issue

ter of friction he failed to see why so many piston-rings were considered necessary. The design of piston-rings was most important, and experience in aero engine design had proved that the friction due to the piston-rings absorbed the major portion of the engine friction. A narrow ring with only a small amount of spring was the best. In the matter of fuel economy this was higher in the Diesel than in the "Semi-Diesel," and there was less "blowing down" of the gases with less wear

the trouble involved in cooling the combustion-chamber, and the design of the inlet-valve cam. In the matter of lubrication there were difficulties with the use of Tar-Oil fuel, as this was an enemy to lubricating-oils. As to the reliability of the "Semi-Diesel" engine he had heard of a good many cracked hot-bulbs. These did not appeal to him for high powers. Mr. Windeler also pointed out that good results had been obtained from the use of aluminum-alloy pistons.

Our Readers' Opinions

(The publication of letters does not necessarily imply Editorial endorsement of opinions expressed)

"CAMMELL-LAIRD-PULLAGAR MARINE OIL-ENGINE"

To the Editor of "Motorship,"

Sir:

With reference to the article in your November issue on "The British Welded Steel Motorship" which principally concerns the above engine, we fear that the matter given may lead our readers to incorrect conclusions on this important oil-engine development. In the first place your drawings and photographs are of a land type Pullagar Gas Engine, and not of the oil-engine as mentioned underneath the illustrations and in the context of your article. Our marine type oil-engine is designed as an open slow-speed one, and runs at practically the same speed as equivalent powered steam engines, and was wholly designed and perfected by Cammell Laird & Co., Ltd. the principal feature, viz., the crossrods, being retained from the gas engine design. The engine for the ship under consideration is of 450 B.H.P. and runs at the low speed of 120 R.P.M. As a matter of fact other oil engines of this power generally run at speeds of 200 to 250 R.P.M. making the propeller less efficient.

We should be glad therefore if you would kindly insert this letter in an early issue of your journal, since it is very important that nothing should

appear that would convey wrong impressions of what is really being accomplished.

Yours faithfully,

CAMMELL LAIRD & CO., LIMITED,
Geo. J. Carter, Managing Director.

Shipbuilding and Engineerings Works,
Birkenhead.

29th November, 1918.

[We endeavored to make it clear at the time that the description and illustrations of the engine built by Allens was given by us merely to give a comprehensive idea of the Cammell Laird engine. Our remarks on page 22 of the November issue were as follows: "This engine was designed by Mr. W. H. Fullegar, of Newcastle-on-Tyne, and was constructed by W. H. Allen Son Company, of Bedford, England. It will serve the purpose of explaining the principle of operation and design to our readers and later on we hope to give details of the engine actually installed in the ship." However, we are glad to afford space to Sir Geo. Carter's letter and thus make doubly sure that no incorrect impression is made.—Editor.]

A MARINE ENGINEERING COURSE

Sir:—Knowing that you are interested in all things pertaining to ships and shipbuilding, I am

taking the liberty of calling your attention to a new course in marine engineering to be given at the Polytechnic Institute of Brooklyn. It will be in the Evening Department, and will start shortly after January 1st. The class is open to college graduates, and to others having adequate preparation, which will correspond in a general way with that given by the first two years work in a good technical college.

The course is intended to be of particular value to those who are now employed in some one of the various forms of marine activity in New York and vicinity, who intend to remain in it, and who wish to supplement their present technical qualifications by further study. It will concern itself primarily with the steam power plant of a modern ship, and the calculations involved in its design, construction, testing and operation. A study of the subject of resistance and propulsion will also be included, and consideration given to the use of the internal combustion engine. The methods of lecture, recitation, reference study and drafting will be used in the course of the work.

Two other new evening courses will be started about the same time; Theory of Aeronautical Engineering, with about the same prerequisites as the course in Marine Engineering; and Tool and Fixture Design, open to men having a good knowledge of mechanical drawing and of modern machine shop practice.

Very truly yours,

E. F. CHURCH, JR.,

Professor of Mechanical Engineering,
The Polytechnic Institute, Brooklyn-New York.

Swedish Standard Steel Motorships

Vessels of 2,500 tons D.W.C. Fitted with Twin 500 bhp. Two-Cycle Diesel Engines

In previous issues of "Motorship" we have referred to the standardized motorships building at the Finboda shipyard, Finboda, Sweden, and we are now enabled to give drawings of these interesting little vessels. Apparently vessels of this size are popular in Scandinavia, because the Danish Government has a fleet of similar sized Diesel steel motorships on order with Burmeister & Wain of Copenhagen. The Swedish vessels have the following dimensions:

Length O.A.	286 ft.
Length B.P.	275 ft.
Breadth (Moulded)	41 ft.
Depth	25 ft.
Draught (Loaded)	17 ft.
Dead-Weight Capacity	2,500 tons
Power (Indicated)	1,300 I.H.P.
Power (Shaft)	1,000 B.H.P.
Bore and stroke of engines ..	15.748 in. by 28.346 in.
Number of cylinders per engine ..	6
Number of propellers ..	Twin
Propeller diameter ..	8 ft. 10 in.
Makers of Engine—A/B Atlas Diesels Motorer, Stockholm, Sweden.	

Each vessel is of the shelter-deck type, with the machinery right aft, leaving the whole of the fore part free for cargo. She is fitted with a double bottom throughout, while the part abaft the engine room is divided longitudinally by a watertight bulkhead and by oiltight decks into 12 independent tanks for ballast and fuel oil. The cargo space is divided into two holds, with five hatchways in each deck, these being served by 10 wooden derricks, each 32 ft. in length, with seven 7 in. by 10 in. steam winches. The winch furthest aft is especially arranged for warping. Included in the deck machinery are also a 9 in. by 11 in. steam anchor windlass and an 8 in. by 8 in. steam steering engine.

Quarters for the captain are provided on the bridge deck, while in the deckhouse below are the saloon, a berth for the chief engineer and two spare berths for passengers. The mates and engi-

neers are accommodated in a large deckhouse over the engine-room, in the after-end of which and also below the main deck are quarters for the crew. All the living accommodation is fitted with steam heaters and electric light.

Fitted to each main engine are two cooling water pumps for the cylinder jackets, two ditto for the pistons which are water-cooled, two bilge pumps, two waste oil pumps, one fuel pump for filling the running tanks, and one sanitary pump. Besides the air bottles for the fuel injection and the reservoirs for the starting air an additional receiver is provided for the deck and engine-room auxiliaries, the air for this service being passed through a tubular heater on its way to the machines.

The separately-driven auxiliary machinery is only used in port and as a standby in case the pumps and compressors driven by the main engines fail at sea. The following auxiliaries are provided:

One air-compressor, driven by a 25 B.H.P. Diesel engine.

One small ditto, driven by an electric motor of 7½ B.H.P.

One hand air-compressor.

One 7½ kw. dynamo coupled to a 12½ B.H.P. Diesel engine.

Pump for filling the daily running tanks, driven by a 1 B.H.P. electric motor.

Duplex steam ballast-pump with a capacity of 115 tons per hour, which can also be driven by compressed air.

Duplex steam donkey-pump for circulating the water through the condenser for the steam winches and steam auxiliaries in the engine-room.

One reserve electric generator, driven by a De Laval steam turbine.

Two donkey boilers each with a heating-surface of 500 sq. ft. and a working pressure of 100 lbs. per sq. in. fitted with Worthington steam feed-pumps.

All the steam auxiliaries in deck and in the engine are connected to the compressed air service, so that they can be driven alternatively by compressed air.

THE MADISON-KIPP COMPANY CHANGES ITS NAME

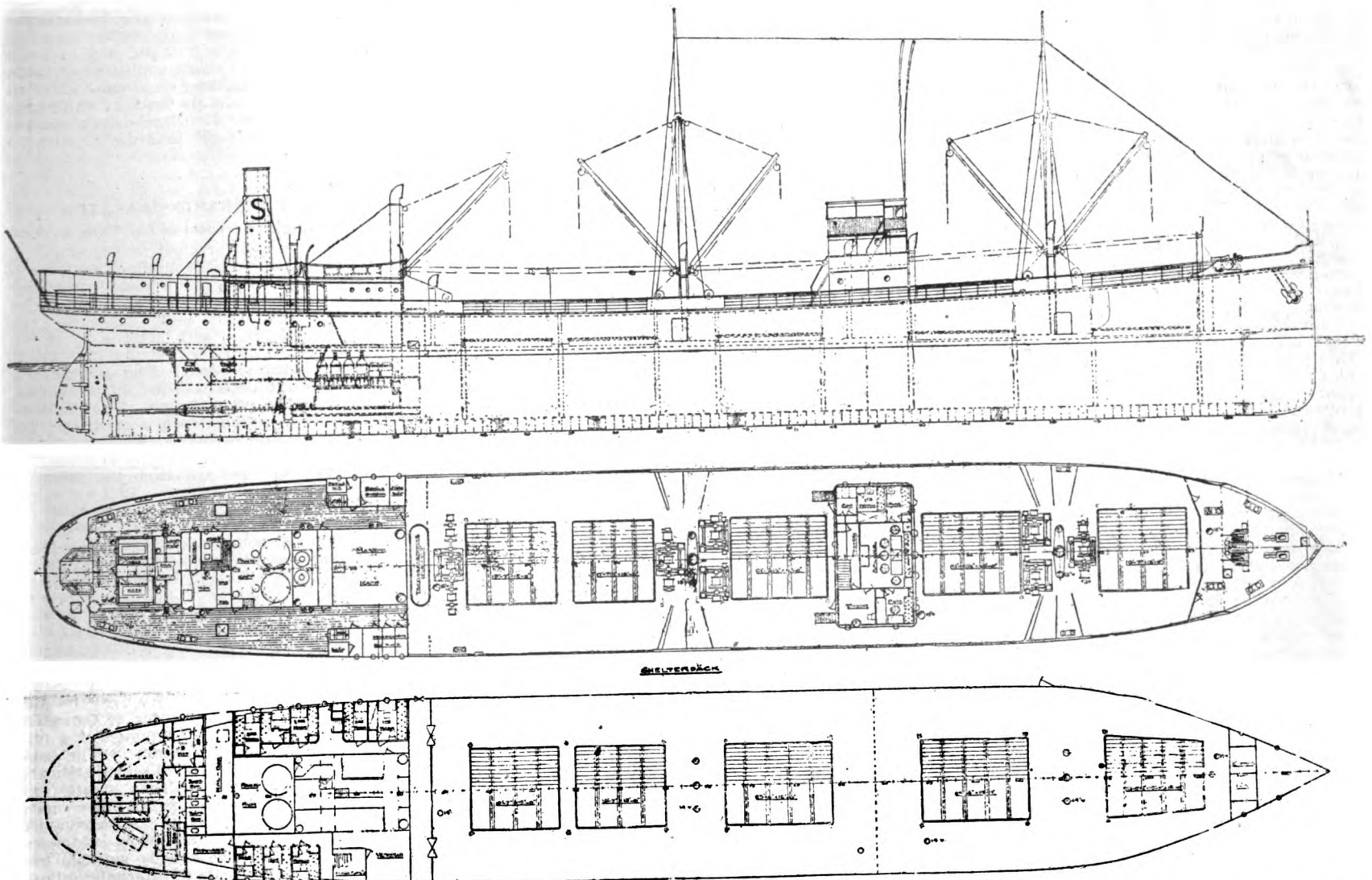
The Madison-Kipp Lubricator Company has announced that its incorporated name has been changed to Madison-Kipp Corporation; but there will be no change in the personnel or organization, or policies of the corporation.

THE FUTURE OF GOVERNMENT-BUILT MERCHANT SHIPS

Under the law as it now stands (Shipping Act of 1914) the U. S. Shipping Board must dispose of all its ships within a period of five years after the declaration of peace. The Senate has not yet decided whether this law will be changed, modified, or stood by. The Senate investigation into the doings of the Emergency Fleet Corporation, and the results of Mr. Hurley's European trip probably will produce the decision on these points.

A CORRECTION

In a recent issue of "Motorship" we gave a description of five concrete water tank-boats under construction for the U. S. War Department. In this article it was stated that the main propelling engines were Winton gasoline motors. We have been informed, however, that in these five boats 120 B.H.P. Frisco-Standard distillate engines will be installed. For auxiliary power there will be 25 H.P. Frisco-Standard engines connected to 2-8 in. Kroag Pump and a 10 H.P. Frisco-Standard motor direct connected to 3-5 K.W. electric generator; also a Frisco-Standard motor-driven hoist for each boat. Altogether 25 engines were ordered.



General arrangement plans of the standardized 2,500 tons d.w.c. steel motorships building in Sweden and described on this page. Diesel heavy-oil engines of the two-cycle type aggregating 1,300 I.H.P. are being installed in each vessel.

Some Candid Opinions Re the M. S. "Bullaren"

To the Editor of "Motorship":
Sir:

Although not an expert in marine construction, I take real pleasure in responding to your request for my impressions of the motor vessel "Bullaren" after my visit. I was distinctly pleased with the "Bullaren" and came away from her strengthened in my belief that the Diesel-driven vessel possesses certain clearly defined advantages over the ordinary steamship.

These advantages, as I see them, may be briefly enumerated:

(1) Less labor is required—I was particularly impressed with the economy demonstrated by the "Bullaren" in the small number of men required to operate the engines, and in the total elimination of the customary force of stokers.

(2) Much space—ever a prime importance to a cargo carrier—is saved. I was really surprised at the volume of this saving as shown in the "Bullaren," with her compact engines in striking contrast to the huge bulk of steam-engines and boilers embodying like power, with no coal bunkers to take up valuable room, and with the fuel-oil carried in the double bottom to the further saving of space and the better stabilizing of the ship.

Taken as a whole, the "Bullaren" won my unstinted admiration. The conservation of space for cargo-carrying uses; the elimination of stoking, and the general economy and improved efficiency of the entire operating plant, all made strong appeal to me.

In a word, I cannot but feel that very attractive

business possibilities are embodied in the operations of these Diesel-driven ships. Not only is this ship a good business proposition, to my mind, but it also clearly conserves the best interests of labor, ensuring for the operating crew better and roomier quarters, and making the work infinitely cleaner and lighter.

In short, I can see no reason why both investors and representatives of labor should not heartily co-operate in advocating the widest possible extension of the use of Diesel engines.

Yours very truly,

R. W. LEATHERBEE,

Assistant Manager, Industrial Relations.

United States Shipping Board,
Emergency Fleet Corporation,
Philadelphia, Pa.

Jan. 10th, 1919.

December 31, 1918.

To the Editor of "Motorship,"

Sir:

Of the economic advantages of a reliable motorship of the type of the "Bullaren" there is not the slightest doubt, as compared with a coal-burning ship. These advantages have been so well covered in your descriptions of these ships in the past that it is hardly necessary to enter into them now. I am thoroughly convinced that oil-driven ships, either those using oil as fuel under steam-boilers, or in internal-combustion engines, are the feature which will place our mercantile

marine in position to compete with the rest of the world on the seas.

Very truly yours,

JOHN A. DONALD,
Commissioner.

United States Shipping Board,
Washington.

To the Editor of "Motorship":

Sir:—

The writer was very much interested in his inspection of the motorship "Bullaren" and, of course, his opinion agrees with all of the others who visited the ship and who have considered the motorship question, namely, that it has decided advantages over steam-powered vessels. It is quite possible that there may be disadvantages when compared with steam-driven vessels; but, we have not been able to figure out what they are. The only two points we can conceive of is a possible question of reliability and the necessity of obtaining the fuel in foreign ports, as up to this time we understand that oil-fuel is not as universally distributed as coal.

Yours very truly,

COLUMBIAN BRONZE CORPORATION,
Louis J. Hall,

President.

[The fuel-question is decidedly in favor of the motorship, as she can carry sufficient fuel in her double bottom for several long round voyages, which enables fuel to be bunkered where it is cheapest.—Editor.]

CUNARD STEAMSHIP CO. AND MUNITIONS

The Cunard Co.'s national shell factory started in 1915 has completed over 410,000 shells, of which not one has failed to pass the firing test. They were 4.5 in., 6 in. and 8 in. shells. About 800 hands—mostly women and girls—were employed. From ship operation to munition manufacture is quite a novel departure.

CONVERSION OF THE "ANNA"

At Whitstable, England, an interesting conversion job recently has been completed by the Kentish Shipbuilding and Engineering Co. This was the old Russian sailing-ship "Anna" which was wrecked at Weymouth a year ago. The hull has been rebuilt and made as auxiliary power-vessel, two Invincible surface-ignition oil-engines having been installed. On trial a speed of six knots was attained on a commission of 0.5 pint (British Imperial standard) of fuel-oil per b.h.p. hour. The "Anna" is of 650 tons d.w.c. The work was supervised by Mr. J. H. Morris, of the above company.

INCREASE OF BRITISH NAVY DURING THE WAR

Work of the British Submarines

From August, 1914, to November, 1918, the following warships were added to the British Navy according to an official announcement, viz:

Battleships	7
Battle Cruisers	5
Light Cruisers	26
Monitors	17
Destroyers	230
Mine Sweepers (and Special Craft)	232

In addition to the above vessels, we understand that a large number of submarines and submersible-cruisers were built, including the 2,000 ton K-class boats. During the war British submarines destroyed two battleships, two armed cruisers, two light cruisers, seven destroyers, five gunboats, twenty submarines, and five armed auxiliary vessels. In addition, three battleships and one light cruiser were torpedoed, but reached port badly damaged. One Zeppelin also got back to port badly damaged after having been attacked by a submarine.

Other enemy craft destroyed by British submarines were fourteen transports, six ammunition and supply ships, two store ships, fifty-three steamships, and 197 sailing ships. In no case was a merchant ship sunk at sight.

In addition to carrying out their attacks on enemy warcraft, the submarine played an important part in convoy work. In the third year of the war one of the British submarine commanders carried out twenty-four cruises, totalling 22,000 miles, which probably constitutes a record for any submarine. In the first and second years of the war seven British submarine commanders carried out a total of 120 cruises, extending for 350 days, all of which were actually spent in the enemy theatre.

GERMANY'S LARGEST SUBMARINE

According to daily paper reports Germany has just turned over her largest submarine to France. She is said to be of 2,700 tons displacement and 342 feet long.

THREE NEW AMERICAN MOTORSHIPS

Via England a report reaches us that three motorships are being built for Hanneveig, Inc., of New York City, at Sturgeon Bay, Wisconsin, of 3,000 tons d.w.c.; 267 ft. long, 46 ft. beam, and 26 ft. depth. Two of the vessels will be powered with twin 500 h.p. Scandia surface-ignition oil engines. But we will not vouch for the accuracy of this report.

LOW-POWERED DIESEL-DRIVEN FERRY BOAT

Between Snaroen and Christiana, Norway, a 50 B.H.P. Diesel oil-engined ferry-boat of 61 ft. length is in the service. Her four cylinder two-cycle motor was built by the A/B Atlas Diesel Motorer of Stockholm, and the hull was constructed by the Kolbyrnsolk Baatlygerri, Arendal, Scandinavia. She carries 100 passengers at nearly eight knots. Her displacements is 30 tons.

DANISH FISHING COMPANY IN ARGENTINA

A motor fishing company, the Compania Pescadora Nacional, has been formed in the Argentine by a Dane named Gert Holm, with a capital of \$250,000, mostly subscribed in Scandinavia. Seven motor fishing boats are to be built now and designs for these have been drafted by Houmoller Bros., Frederikshaven, Denmark. Later on 17 more vessels will be added. These boats are 59 ft. long, 16 ft. 2 in. breadth and 7 ft. draught and will be installed with Alpha surface-ignition oil-engines.

GERMANY AND MERCHANT MOTORSHIPS

An article by a German naval architect in a Hamburg paper, says "Syren and Shipping," discusses the post-war prospects of the German yards. The writer says that the new yards abroad will be able to compete with the German yards because the high prices paid for war-time tonnage have enabled very high rates of depreciation to be written off. On the other hand wartime tonnage is not going to prove very durable, because of the lack of skilled labor, and the depreciated material used. The altered conditions under which ships have been operated have also caused much greater strain and stress, especially the raising of the loadline. The older German yards will, in the author's opinion, be able to keep their position in the industry, and build cheaper and more profitable steamers, and technically better boats than the standard ships built abroad. But where the German builders will be able to score, he says, will be in the development of a thoroughly reliable oil-engine, which will be based on the experience gained in submarines. The German yards

must devote themselves not to building to compete with the standard ships but to the construction of ships specially designed in hull and engine to operate most profitably in specific trades.

ITALIAN MOTORSHIPPING FINANCE

It is interesting to note that when Gio Ansaldo & Co., the well-known Italian motorship and Diesel-engine builders, increased their capital from 100,000,000 lire to 500,000,000 lire by public subscription, the issue was largely oversubscribed. The number of subscribers reached the remarkable total of 13,337. Consequently all applications for over 25 shares only received 75 per cent of their application. The total fully-paid capital of Ansaldo now amounts to about eighty-six million dollars at normal exchange rate. In the various shipyards of Ansaldo & Co. about 25 Diesel-driven motorships each of 8,000 to 10,000 tons d.w.c., will be completed every year.

COMPOSITE MOTORSHIP "AARSTEN"

A New Grei Oil-Engined Vessel of 657 Tons D.W.C.

Owing to the shortage of steel in Scandinavia, the composite system of shipbuilding has lately come into vogue, one of the first vessels in Norway to have wood planks on a steel frame being the motorship "Aarsten." This vessel measures 145 ft. between perpendiculars, with a beam of 26 ft. and a moulded depth of 13 ft. 1½ ins., her dead-weight capacity being 657 tons. The planking is of 4 in. fir, while the deck is 3 ins. in thickness, with beams at every other frame. The hold is provided with two hatches each served by two Skandia motor-winchs having a capacity of two tons. By means of driving chains, the anchor windlass can also be operated from the forward winch, while a pump for the bilges and deck washing is driven in a similar manner.

The propelling machinery consists of a 240 b.h.p. four-cylinder directly-reversible Grei surface-ignition oil-engine, which runs at 290 r.p.m. Starting and reversing is effected by compressed-air, which is stored in a reservoir charged from the explosion pressure of the cylinders to 250 lb. per square in. The consumption of this engine is guaranteed not to exceed 0.57 lb. per B.H.P. hours.

CAMMELL LAIRD AND DIESEL ENGINES

In the report of the war activities of Cammell Laird & Co., Ltd., of Birkenhead, England, the following interesting paragraph appears: "The submarine department, which had been instituted shortly previous to the war, has been greatly extended, and is now capable of turning out a number of these deadly craft annually, complete, with their machinery and outfit. It may be said that the engineering plant will be equally suitable for the production on a large scale of internal-combustion engines for merchant vessels, which is, in the company's opinion, one of the engineering developments of the near future."



The motorships "James W. Simmie," "Solata" and "Maggie" under construction at Bolinao, in the Philippine Islands. American-built oil-engines are installed.

Motorship Construction in the Philippine Islands

A Number of New Wooden Oil-Engined Auxiliary Schooners Fitted with Fairbanks-Morse, Kahlenburg, Bolinder and Skandia Motors

During the last year or two the heavy-oil engine has become exceedingly popular among shipping and shipbuilding interests in Philippine Islands, the market being about evenly distributed between American and Swedish engine-builders, while the hulls are constructed locally, in some cases from British design. If the field is properly studied and handled there should develop quite a substantial market for this class of engine.

From one of our readers, Capt. J. Henning, Superintendent of the Luzon Shipbuilding Company, Bolinao, Pangasiman, P. I., we have received illustrations and brief particulars of some wooden-built motor-auxiliary sailing-vessels built and building at that yard.

One of these is the "James W. Simmie," which was the first vessel launched from the Luzon shipyard, and this event took place on August 22nd last. Her dimensions are as follows.

Length	140 ft.
Breadth Over Planking	30 ft. 6 in.
Depth of Hold	10 ft.
Tonnage	550 tons dwt.
Power	180-200 I.H.P.
Speed Under Power Only	9 Knots
Sail Area	9,000 sq. ft.

We are glad to see that their first vessel was not underpowered like many of the motor-auxiliary sailing-ships built in America during the first "boom" in this class of craft. Her engine is a four-cylinder Skandia surface-ignition motor of 180-200 B.H.P. This is of the two-cycle type.

The "James W. Simmie" will be put in service on a route between Manila and Palawan and Balabae Islands, connecting the most virgin possessions with Manila in monthly trips. There is passenger accommodation for 20 first-class passengers.

The other two vessels under construction are the motor-schooners "Lolita" and "Maggie" built for Cebu interests: "Lolita" for Mr. Ramon Abolite, a well-known merchant of Cebu, and the "Maggie" for Capt. William Gordon. These two vessels are built for their particular trade in the Visayan islands and were recently launched. Both vessels are auxiliary powered. The "Lolita" will be fitted with 100 H.P. Fairbanks Morse oil-engine. The "Maggie" will have a 100 H.P. Kahlenburg oil-engine. These two vessels are approximately 200 tons each. This yard now is laying off a 50 net-tons full-powered

twin-screw motor schooner for the interisland lumber trade.

At another wooden shipyard in the Philippine Islands has been built a 500-ton dwt. motor auxiliary to the order of the M. J. Ossorio, of Manila, from designs by John A. McCallum, of Glasgow, Scotland. This vessel is classed at Lloyds as 8A1 under 400 tons, and is used in the coastwise lumber trade around the Philippine Islands. She carries sufficient stores and fuel to make one trip round the islands from Manila, calling at intermediate ports, the entire voyage occupying one week. Her principal dimensions are:

Length Overall	163 ft. 3 in.
Length, On Load Waterline	140 ft.

Breadth, Extreme	32 ft.
Depth, Moulded	14 ft. 3 in.
Depth of Hold	13 ft.
Draught to Top of Keel	10 ft. 9 in.
Draught to Bottom of Keel	12 ft.
Deadweight Carrying Capacity (About)	500 tons

She is rigged as a two-masted schooner and the total sail area is 7,215 sq. ft. In addition, the vessel is provided with a four-cylinder oil motor of the Bolinder surface-ignition type for auxiliary use in propulsion. This engine is of 240 B.H.P., and is capable of giving the vessel, when fully loaded and running under power alone, a speed of 7 knots. The general arrangement of the vessel can be seen from the longitudinal elevation and the deck plans. [Owing to great pressure in space we have been obliged to hold over the plans until March.—Editor.]



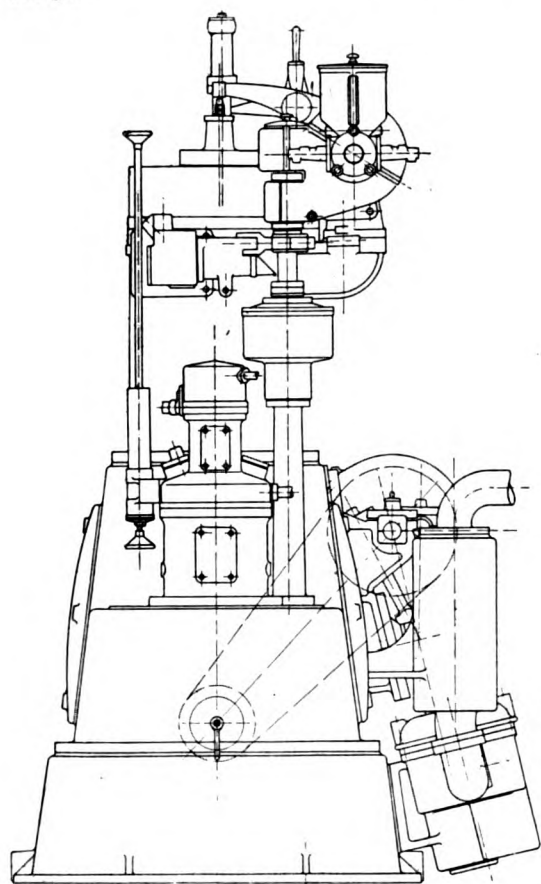
The Philippine motorship "James W. Simmie" ready for her masts and for fitting out.

Development of the Werkspoor-Diesel Marine-Engine

Nine Years' Experiences of the Nederlandsche Fabriek, Amsterdam

By GERARD LUGT, Chief Diesel-Engine Designer of Werkspoor

THE first ships, for which Werkspoor (Nederlandsche Fabriek), Amsterdam, built Diesel engines are the "San Antonio" and the "Cornelis", both of about 1000 tons displacement. These vessels were built in 1909-1910 and their engines are not special marine engines, but are 4-cylinder stationary engines of the enclosed type of about 200 B.H.P. each. The water-jackets of the cylinders are combined in one casting which is bolted to the cast-iron crankcase also cast in one piece and provided with large size hinged doors. The cylinder liners are inserted from above and closed by the four separate cylinder-heads of usual design.



Engine of the M.S. "Cornelis," built in 1909.

The camshaft is driven by means of helicoidal gear and an intermediate vertical shaft, on which the governor is placed. The governor regulates the speed as is usual in ordinary stationary Diesel-engines by acting on the suction-valve of the fuel-pump. The latter derives its motion from the vertical shaft by means of a horizontal eccentric. The air compressor is mounted on an extension of the crankcase and driven by an overhanging crank shrunk on the crank-shaft.

The cooling water and bilge-pumps are attached to the back of the crankcase and are chain-driven from the crank-shaft. The motor is provided with forced lubrication; the pistons are of the open trunk type.

This engine is not reversible, the manoeuvring taking place by means of a reversible-blade propeller, and it is possible to reverse the blade from the bridge, the crankshaft and the tunnelshaft being connected by a friction-clutch. Though these engines bear little resemblance to the Werkspoor-Diesel marine engine of to-day yet, a principal element of the latter is already present, viz., the combined water-jacket for several cylinders, the so-called cylinder-beam. This casting of considerable height has a great resistance to bending stresses, the advantage of which will be shown further on. It stands to reason that these engines did not at once run satisfactorily in every respect. Circumstances on board are too different from those on shore and though Werkspoor possessed considerable experience in marine steam-engine building the experiences with motorships were quite new and not altogether agreeable.

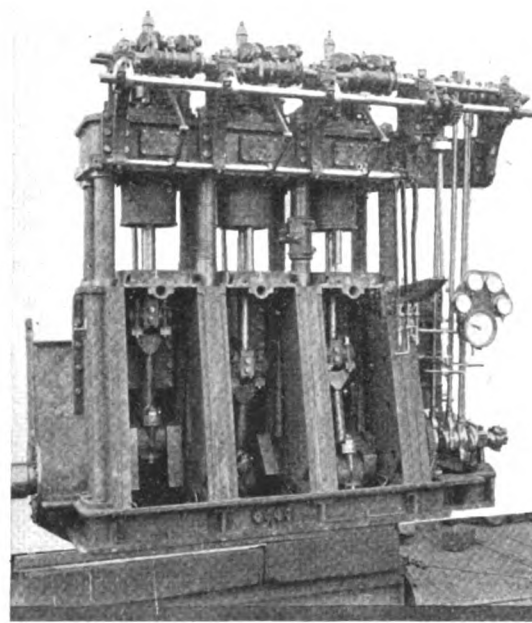
However, it was not the main-engine that gave the most trouble. The friction clutch, the air-compressors and fuel-pumps and the electric power plant caused the principal difficulties. Evidently the reliability of the entire installation depended

for a great part on the engine-room crew, and, as some of the engineers had never seen a Diesel-engine before they were not quite up to their task. Consequently, it may be said that everything that could go wrong actually went wrong and thus every mistake in construction was detected and improved in the following engine. All the same the "San Antonio" and the "Cornelis" have proved to be thoroughly reliable ships, and are still working satisfactorily.

The following ship, the "Vulcanus," was the first full-powered Diesel-engined ocean-going vessel in the world, 1910; her engine of 500 B.H.P. in 6 cylinders was made directly-reversible and shows many features of the ordinary marine steam-engine. Up to date the "Vulcanus" has covered about 300,000 nautical miles. Along the front of the cylinders of her engine is a shaft corresponding to the weigh-shaft of the reversing gear of the steam engine.

This shaft bears two-armed brackets, the arms of which are terminated in bearings, carrying two camshafts, one for ahead, the other for astern. On the after-end of both shafts a gear-wheel is keyed, meshing with a pinion of half the number of teeth. This pinion is seated on intermediate shaft, in line with the above-mentioned weigh-shaft. The intermediate shaft is operated by means of cranks and connecting rods from two eccentrics on the crank shaft. When the weigh-shaft is turned, the two gear-wheels rotate round the pinion and either the ahead or the astern camshaft may thus be put underneath the rocking-levers working the valves.

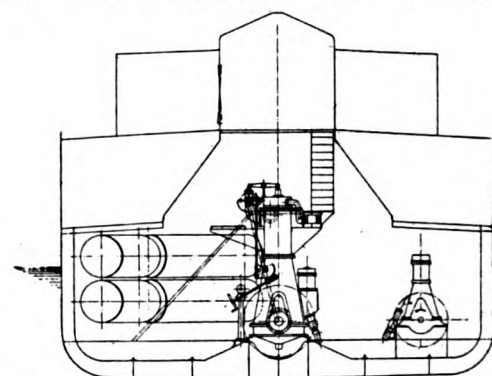
Thus the intermediate vertical shaft with helicoidal gear is entirely done away with and replaced by the connecting-rod transmission. The composing parts of the latter are less subject to wear and tear and can be more easily replaced. Moreover, the shifting of the crankshaft caused by the wear of the thrust-block-segments does not throw the timing of the valves out of order. An important departure with respect to the stationary type of Diesel engine of 1910 was the application of cross-heads and separate short pistons, which is another point of resemblance with the steam engine. It is true that this construction makes



Probably this is the only successful three-cylinder, direct-reversible four-cycle type Diesel engine in the merchant marine. It is the engine of the M.S. "Sembilan." It has been in regular operation for eight years.

the motor higher than those with trunk-type pistons; but the advantages are very important. The motor is more accessible, there is less heat-accumulation, no more side-thrust on the piston, and the latter can be more easily removed by unbolting it from the piston-rod flange. The piston of the "Vulcanus" engine is a contrast with the later type of marine Diesel engines of other design which have to be removed upwards by taking off the cylinder-covers. The "Vulcanus" pistons are hollow and cooled by air which is admitted by means of telescopic tubes. They are provided with eight piston rings to retain the high pressures.

The piston-rod passes through the stuffing box of an oiltray, separating the crank-case from the cylinders, which is very useful to keep the dirt from the cylinder out of the crank-case; the cylinders being lubricated by six separate exactly timed lubricating-pumps. The crank-case is closed on three sides by the cast-iron frame, which carries the cross-head guides of ordinary marine type. The remaining iron side is closed by sheet-iron doors, resting against the cast-iron front columns. The crankshaft can easily be inspected when those doors are removed. The main bearings, crank and crosshead-pins and guides have forced lubrication; the oil-pump is



Section of the engine-room of the M.S. "Vulcanus."

of the oscillating valveless type and is worked by an eccentric on the crankshaft. The six cylinders are combined in two separate groups of three cylinders, inserted in cylinder-beams (or cooling water tanks) as above described. Each of these beams is connected to the bedplate by eight turned steel stays which form the principal part of the later type of the Werkspoor-Diesel marine engine. I will talk about this construction more extensively when treating the engine of the "Juno," which was the next larger motorship.

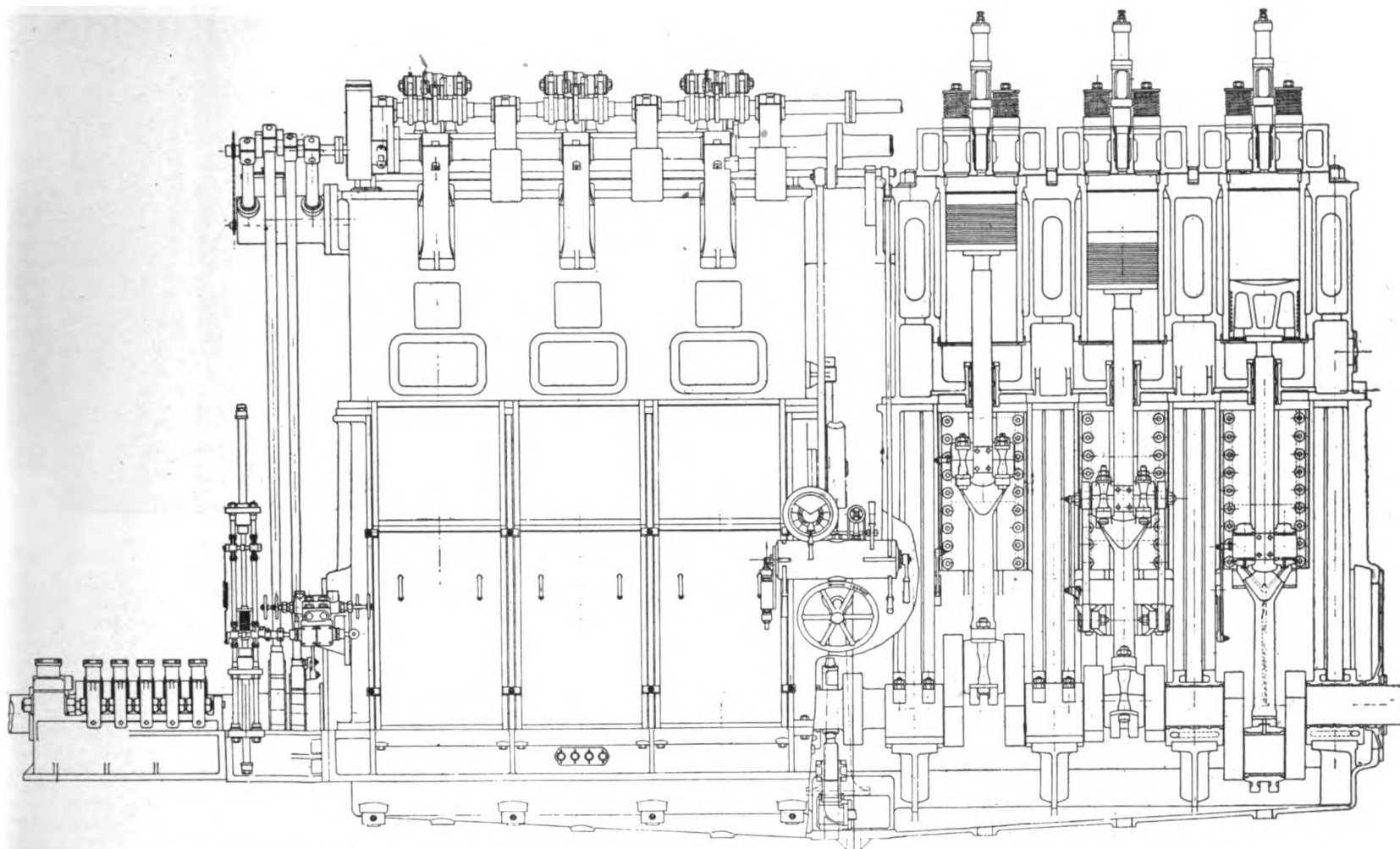
Manoeuvring the motor is carried out from one central point, where the various control levers are arranged exactly as usual on steam engines. To the left we find the hand throttle-valve for the fuel supply, to the right the levers which control the position of the compressed air and fuel valve rockers. Below these levers is the reversing wheel.

In contrast with the preceding engines the "Vulcanus" engine has only one fuel pump common to all the cylinders, which is driven from one of the eccentrics on the crankshaft. This arrangement increases the reliability considerably, as the small delicate fuel-pumps with their great number of tiny valves are done away with. The new pump is made out of a solid steel forging; the valves are steel balls that can never stick or get out of order and are easily accessible.

The air-compressor is of the three-stage type; the L.P. stage is driven by rockers and links together with cooling and bilge-pumps; the I.P. and H.P. compressor are placed one on top of the other and driven in the same way as the L. P., but from another crosshead. Coolers are fitted between the different stages.

A separate 50 H.P. auxiliary Diesel engine, driving an air-compressor of the same capacity of the main compressor. This fills the starting-air reservoirs with air of twenty atmospheres (280 lbs.) which is used for manoeuvring the main engine. The above mentioned engines of earlier date than the "Vulcanus" engine all used starting-air of sixty Atmos. (840 lbs.) Though some mishaps have occurred in the first years of her operation, the results of the "Vulcanus" have been entirely satisfactory, and she has been in service now for over eight years.

The next marine motor that was constructed, the one of the "Sembilan," 1911, again shows some important alterations. The reversing mechanism of the "Vulcanus" was modified in such a way that the two camshafts do not turn round a weigh-shaft, but slide over brackets, the bearings of these camshafts being combined in one casting. These castings are connected to levers on a third shaft which takes the place of the weigh-shaft. This weigh-shaft which is turned by means of worm and wormwheel, can be made much lighter than in the engine of the "Vulcanus" as it has only to shift and not to carry the two camshafts. The ahead camshaft is driven by connecting-rods from a four-throw intermediate shaft that runs



The 500 B.H.P. direct-reversible Werkspoor Diesel-engine of the "Vulcanus," which was the first ocean-going motorship, and which has run about three-hundred thousand miles. It was the first marine Diesel engine of crosshead and guide construction.

at half the speed of the engine and is itself driven by a spur-gear from the main crankshaft. The astern camshaft takes its rotary motion from the ahead camshaft by means of the spur-gear.

In applying four, instead of two rods ("Vulcanus") working at angles of ninety degrees, the result is that these rods are never in compression but only in tension, this being very important with regard to their great length. The bottom brasses of the connecting-rod bearings are omitted, which makes it possible to shift the camshaft over a straight surface, the top brasses clearing the crank-pins when the two shafts are in the mid-gear position, coming back into contact when the shaft is in one of the extreme positions i. e. the running positions for either ahead or astern.

Another entirely new feature is the way in which the pistons can be dismantled. The lower part of the cylinder liner is detachable and the piston enters entirely in it when it is in its lower dead center. When the cylinder-extension piece is then lowered down, the piston comes to view, may be inspected and cleaned, broken piston rings may be taken out and replaced by new ones, eventually the piston may be taken out entirely by taking out the bolts fixing it to the piston rod. It needs no explanation that this device means an enormous amount of time saved; to inspect all the pistons of a six-cylinder engine after a voyage does not take more than one day.

The frame of the engine of the "Sembilan" is in the same style as that of the "Vulcanus." On the frontside the detachable sheet-iron doors give full access to the crankshaft and the moving parts; the backside of the frame is entirely closed.

An important alteration is the new construction of the cylinders. As the piston, thanks to the detachable-cylinder-extension can now be removed downwards, a separate cylinderhead is no more necessary. It can be cast in one piece with the cylinder-liner. An important advantage is the greater effectiveness of the water-cooling, especially at the hottest parts of the cylinder and head, as compared to the customary design of stationary engines where heavy masses of cast-iron are found where cooling water is most needed. A number of doors of ample size are provided to facilitate cleaning and inspecting. In those engines where the pistons are watercooled the extension piece is not cooled.

The system of the fuel supply is also slightly modified, though the principle of the single fuel-pump is adhered to. The accumulator of the "Vulcanus" is replaced by the so-called "floating-vessel." This is a reservoir, suspended to a double-armed lever which is balanced by a counterweight. The fuel is pumped into this reservoir by the

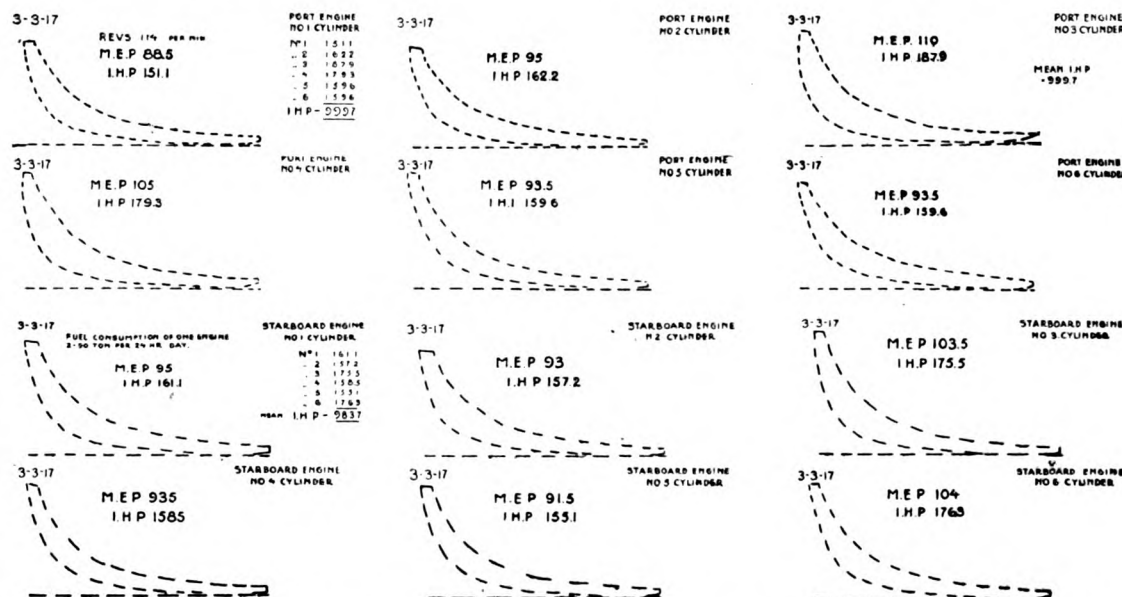
above mentioned fuel-pump. As soon as the amount of fuel pumped into the reservoir surpasses a certain mark, the floating-vessel comes down and by this movement shuts off the fuel supply to the high-pressure fuel-pump. High-pressure injecting air is admitted to the top of the floating-vessel, which is mounted at a certain height above the cylinders so that the fuel can reach the valve cages by gravity. In flowing from the floating-vessel to the valve-cages the fuel passes through the throttle-valve of the emergency governor, through the hand throttle-valve and finally through a distributing box fitted with a regulating spindle for each cylinder. As the floating vessel should not be hampered in its movement, the pipes connected to it are so arranged that they allow of a certain elastic motion.

In the case of the "Sembilan" engine the three-stage air-compressor is placed at the forward end of the engine and directly driven from the crankshaft by means of an overhanging crank and connecting rod. An auxiliary crank-shaft, chain-driven from the main crank-shaft and situated on the back of the engine, drives cooling-water, bilge and lubricating-oil pumps.

The "Sembilan" motor has also forced lubrication.

An auxiliary air-compressor, duplicate of the main engine compressor is driven by a 25 H.P. Diesel engine. It furnishes the compressed air for the air-driven deck winches and for some auxiliary pumps and can, of course, serve as a spare for the air-compressor of the main engine. The fuel supply of the auxiliary engine can take place by its own fuel-pump or by the floating-vessel. All these precautions increase the reliability of the whole plant. [The installation of compressed-air driven-winches is a novelty. Results of operation would be of interest.—Editor.]

The following ship, the "Juno," 1911, may be said to have the first Werkspoor marine Diesel engine in its present shape; though, of course, a great number of minor details have since been changed, when experience has shown it to be necessary or desirable. Though it has much resemblance to the "Sembilan" engine, the considerably larger output (1450 I.H.P. against 275 I.H.P.) required a modified design in various respects. [Recently the "Juno" has been operated by the U. S. Shipping Board.—Editor.]



A set of indicator-cards taken at sea from the engines of the motorship "Sebastian" and given to "Motorship" by Chief Engineer James E. Cole on the occasion of this ship's last visit to New York. This is the same size of Werkspoor engine now building for the U. S. Emergency Fleet Corporation.

Of the usual Diesel-engine frame we find but little left. The connection between cylinders and bedplate is only formed by a set of steel stays without any cast-iron framing. The following considerations led to this construction. The pressure working in the cylinder is on one side taken up by the cylinder cover which is attached to the cylinder-beam by studs, on the other side it works on the piston and through piston and connecting-rod on the crank-shaft and ultimately on the bottom main bearings. Now these main bearings are directly connected to the cylinder-beam by the steel stays; thus the circle is closed in the most direct way and the bedplate is thus kept free of any stresses and may be constructed very lightly. In order to insure the stability in lateral direction, diagonal stays connect the cylinder-beam to the bedplate. The entire construction is very light, but strong and rational and the absence of a cast-iron framing makes the inside of the engine exceedingly accessible.

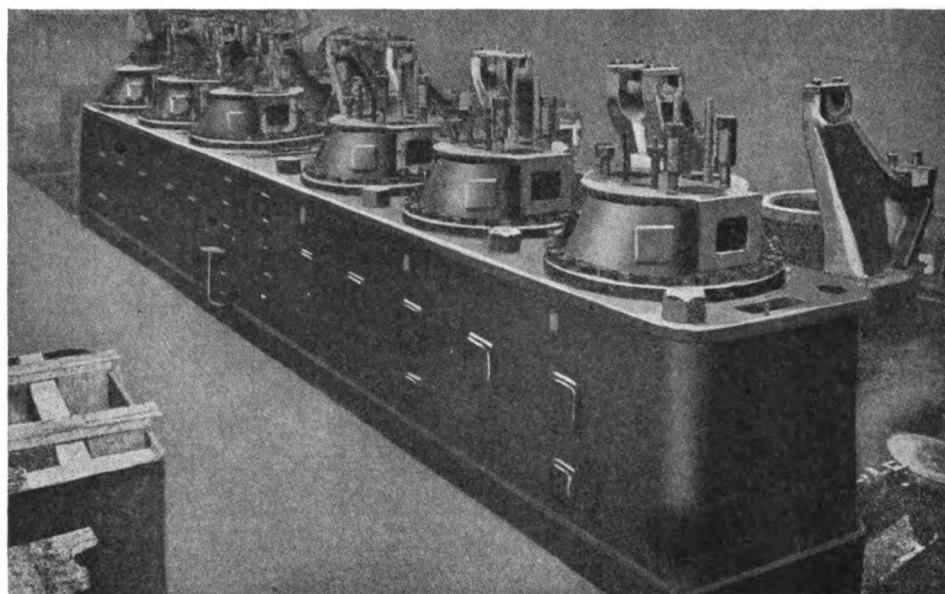
To take up the lateral thrust of the crossheads, cast-iron columns which carry the guides are placed on one side of the engine; they are rigidly connected to the bedplate by bolts; to the cylinder-beam they are connected in such a way that some play in vertical direction is possible. This keeps the cast-iron columns and bed-plate free from the very large forces caused by the explosions inside the cylinders. The cylinder liners are inserted in the above named cylinder-beam, which forms a water-jacket. This cylinder-beam is a casting of great strength and stiffness and insures the necessary rigidity of the entire engine and from this point of view is the main part of it. Looked at in this way the bedplate is really hang-

ing to the cylinder-beam by means of the steel stays, because when the engine is working, there is always tensional stress in these steel stays. At the same time the bedplate can be built very lightly, because the steel stays are placed as near

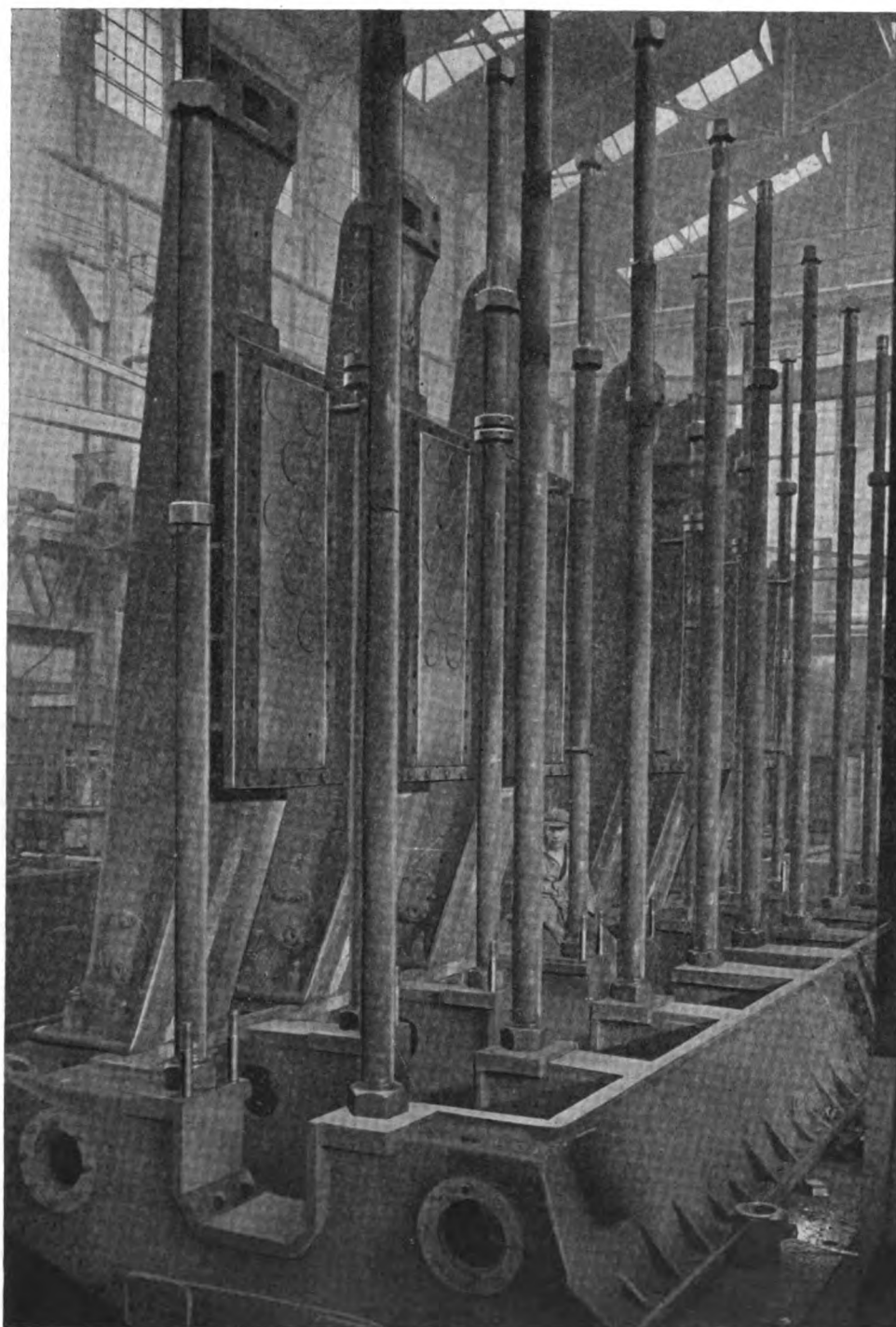
to the main bearings as possible. Constructed on these principles, the motor acquires great accessibility and light weight and yet great strength.

Several of the constructions we met with in the "Sembilan" engine have been taken over nearly unaltered in the engine of the "Juno," for instance the principle of reversing, the dismantling of the pistons, the construction of the cylinders in general and the fuel supply. The reversing gear is now provided with a reversing engine, air driven, that turns the weight shaft. This engine itself can be reversed by changing inlet and outlet; it is controlled by a special lever on the control-box which contains all the levers for manoeuvring the engine.

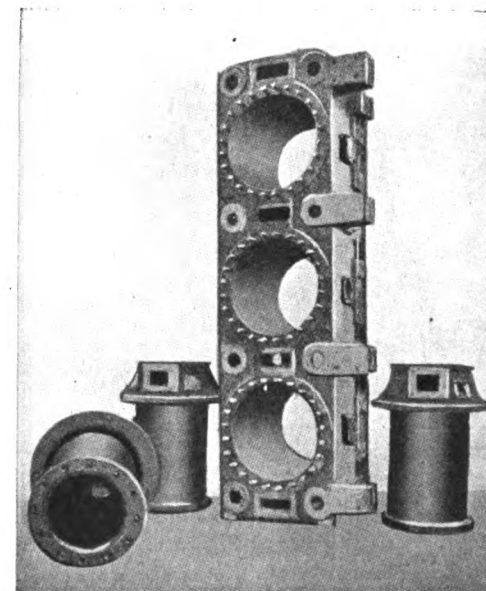
An intermediate crankshaft driven at half-speed from the main crankshaft drives the ahead camshaft by means of coupling rods exactly as de-



The cylinder-beam (or cooling-tank) with cylinders in position



Illustrating the Werkspoor steel column construction which extends from the bedplate to the top of the cylinder-box, and so carries all the stresses of combustion. The cast-iron frame carrying the crosshead-guide also can be seen.

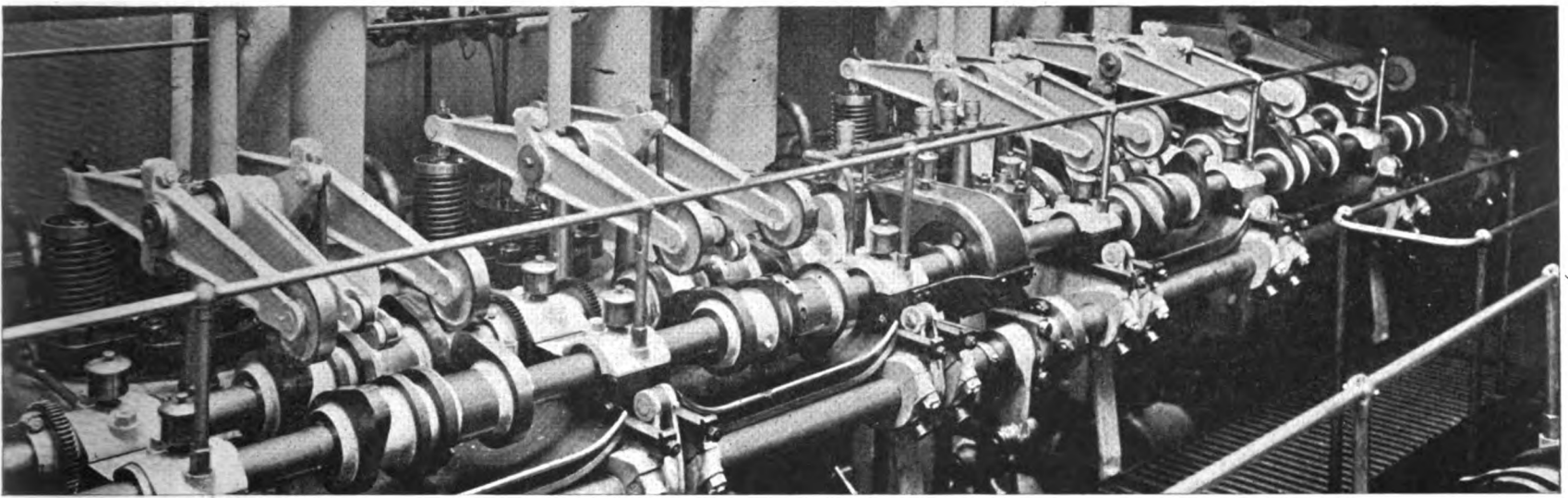


Cylinders and a cylinder-box. Reference to the cylinder lying on its side will show that the cooling-water passes all around the point of greatest heat.

scribed before for the "Sembilan." This intermediate shaft is placed in the middle of the engine. The connecting rods are of such a length that it would not do to make them simply of tubes, these not being stiff enough. The tubes were now cut open on the side for nearly the entire length; the two halves of the tube are forced apart in the middle by distance pieces; this operation gives the rod the shape of a long stretched diamond and makes it exceedingly stiff without increasing its weight.

The piston cooling by air circulation would be insufficient for this size of engine and water cooling was adopted, the water being brought into the piston by means of telescopic tubes.

The oiltrays underneath the cylinders have a double duty to perform. On the one side they prevent the cooling water from leaking into the crankcase where it would spoil the lubricating oil; on the other side no splashing oil can be thrown on the cylinder walls and wasted by being brought into the combustion chamber by the moving of the piston. These oiltrays also serve for attaching the telescopic pipes.



The old double-shaft reversing mechanism now substituted by a diagonal-eccentric and single shaft design of more simple construction, lighter weight and reduced manufacturing cost.

Steel plates are fitted between the columns in front of the connecting rods in order to prevent the oil from being splashed around. The forced lubrication is replaced by sight-feed lubrication as is usual on marine steam-engines; the oil is collected in the bedplate, pumped into a filter and used over and over again.

The fuel supply system is almost identical to that used on the "Sembilan"; a throttle controlled by an ordinary Aspinall governor is put in. After passing through this throttle and the hand throttle valve, the fuel supply pipe is divided into two pipes both leading to a distributing box for three cylinders. These boxes have regulating spindles for distributing the fuel exactly over the valve cages. Special valves in these boxes shut off the fuel supply during the reversing, being connected to the reversing gear. The H.P. fuel pump and the spare high power fuel-pump are driven from the auxiliary crank-shaft, a second spare pump is installed separately and driven by compressed-air. The pumps and the three-stage air-compressor are driven by balance levers and links from the second and fifth crosshead and are bolted to the cast-iron columns.

The heat of the exhaust gases can be used for heating a donkey-boiler which produces steam for the steering-gear and for heating the ship; it is also possible to make the exhaust-gases escape directly through the funnel.

A 100 H.P. two-cylinder auxiliary Diesel-engine drives a three-stage air-compressor, placed between the two motor cylinders. It is used for keeping the manoeuvring-air vessels under pressure. This engine also drives the centrifugal cargo-pump by means of a belt and a few other spare pumps by means of chains. This auxiliary motor is of the same type as the main motor, being provided with crossheads and the special piston dismounted device.

As could be expected after the experience gained with the preceding engines, the "Juno's" motor gave very little cause of annoyance and runs very satisfactorily. It may be mentioned here that some time ago the "Juno" received instructions to tow a large steam-tug from Rotterdam, via Bergen (Norway), to the Dutch West-Indies. She carried this out without any mishaps and then continued her voyage through the Panama canal to the Dutch East-Indies.

After the construction of the Juno-engine the Werkspoor Diesel-engine has only been changed in details. However a good many improvements have been shown to be possible and necessary. These improvements, notably the altered construction of the cylinder heads, increased the reliability of the engines. In the latest type of cylinder head the fuel-valve is no longer squeezed in between inlet and exhaust valve, but is placed slightly out of the centre. Thus ample cooling space is provided between the four valves in the head.

It may be interesting to mention that in the latest design forced-lubrication was again adopted and that the double-shaft reversing-gear hitherto used was superseded by a new system in which only one camshaft is used, on which the cams for ahead and astern running are keyed side by side. The valve levers are all mounted on eccentrics, these being keyed at a certain angle on the lever shaft which serves as reversing shaft. Turning this shaft a half turn brings the levers in contact with either the ahead or the astern cams and lifts them clear of the cams in the intermediate position.

I finally want to say a few words about some special marine engines constructed by Werkspoor.

In the first place mention should be made of

the "Frisco" engine which may be considered as a special type of twin-screw installation. [This engine was illustrated in "Motorship" for February, 1918.—Editor.] The specification asked for a very light and small engine to be built underneath armour deck of a peculiar roof shape. The two motors of six-cylinders each are inclined toward each other in such a way that the tops of the cylinderbeams could be connected up over the entire length. At the same time the bearings of the two engines are connected by cast-steel frames. Thus a triangular engine frame of great rigidity was formed and considerable weight was saved as no diagonal stays or cast-iron columns were necessary.

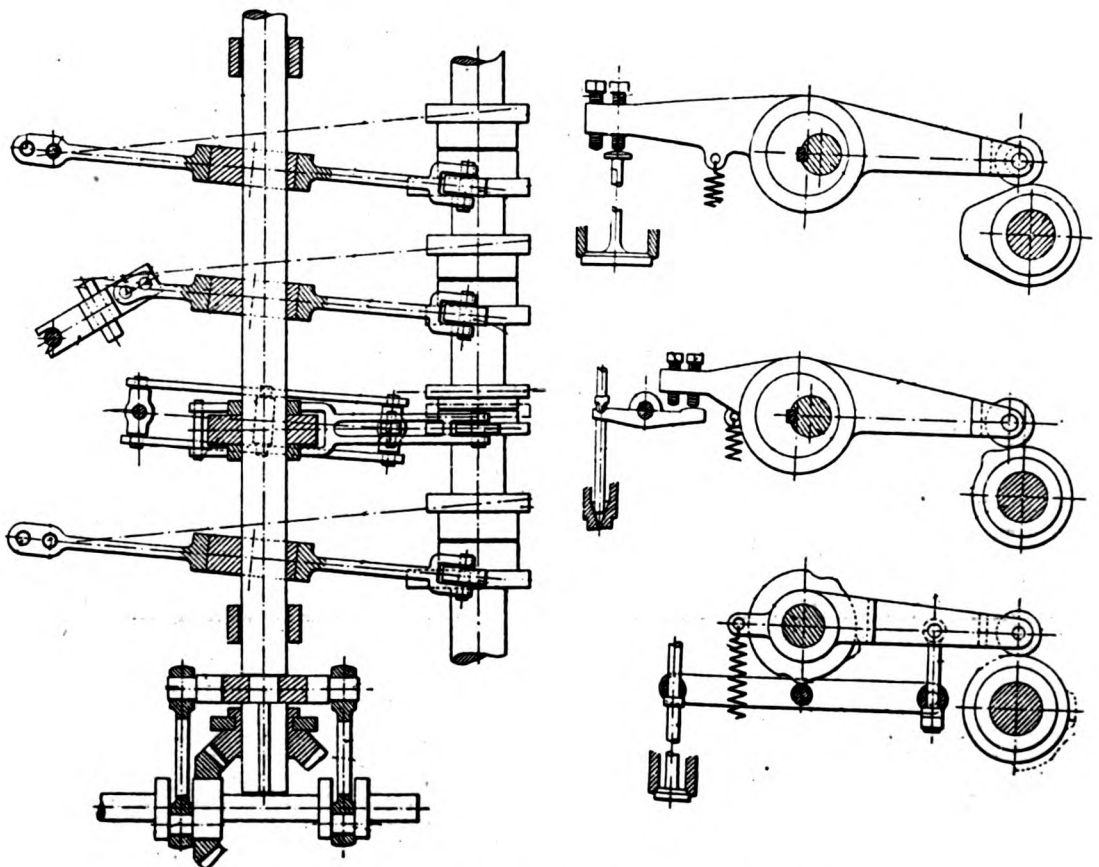
Yet the engine does not vibrate perceptibly even when developing its full power. The available space being very small, pistons of the trunk-type were used; however, the cylinder construction with detachable extension-piece was applied. Placing the piston in its lower dead center and the detachable cylinder-extension being loosened, these parts may be turned around the crankpin, the cylinder-extension is then slipped off and the piston may be inspected and eventually the cross-pin may be taken out.

At the forward end the two three-stage air-compressors are placed, between them are the control boxes for both engines. This engine develops 1200 B.H.P. at 300 revolutions per minute and weighs less than 33 tons, the flywheel included. [60 lbs. per shaft horsepower at 300 R.P.M. is indeed light—Editor.]

For smaller ships the auxiliary air-compressor

needed with every reversible engine, increases too much the first cost of such an installation. For this reason Werkspoor has adopted for marine engines under 500 B.H.P. a type of non-reversible engine equipped with a reversible-blade propeller as already described for "San Antonio" and "Cornelis," in "Motorship" for September, 1916. This non-reversible engine, of course, is built in the same style as the larger reversible ones and we may find several of the above-mentioned "Werkspoor" features embodied in it. The oil-reservoir under pressure is not required as the engine now continues to run in the same direction even if the propeller blades are in the middle position and the motor is almost running light. Therefore four separate fuel-pumps are fitted with an ordinary governor. These four pumps are combined in a solid steel forging and are driven by eccentrics on the auxiliary camshaft. The largest engine of this type built at present time develops about 350 B.H.P., and has been installed in the motor-vessel "Poseidon," "Castor," "Escalante"; twin-screw installations have been furnished for the motor-vessels "Utrecht" and "Tydeman" and are giving entire satisfaction.

I cannot close this article without mentioning the motorship "Sebastian," equipped with a twin-screw installation of 1700 B.H.P. In this ship two-cycle Diesel engines had been installed originally. The owners were so little satisfied with these engines that they resolved to take them out and replace them by Werkspoor engines, which were put in the ship by Smith Dock Co., Ltd., at North Shields, England, without having been tested at



Sketch of the new Werkspoor reversing mechanism.

all in the shop. The installation was taken over by the owner during the first trip to London, and the "Sebastian" then left immediately for New York. The distance of about 3,450 miles was covered in about 380 hours at a total daily fuel-consumption of 5.9 tons. Not including water, fuel, and stores, this ship carried 4,100 tons of cargo, on a fuel-cost of \$82½ per 24 hour day, with oil at \$2.00 per barrel.

Editorial Note.—Recently "Engineering" of England devoted about six pages to an illustrated discourse on the Werkspoor-Diesel marine engine and perhaps some of their remarks will be of interest. Referring to what has been accomplished "Engineering" says:—"This represents quite a comprehensive experience, but its value is much increased by the fact that Diesel-engined ships do not usually make Amsterdam a port of call. They are put upon routes where oil is plentiful and

comparatively cheap, and hence the builders can do nothing to nurse the engines. They send them away in charge of engineers who have little experience of such machinery, and who are apt to be replaced by others who know still less about it. The result is that every weak spot is discovered by the very effectual method of being tested to destruction. Such an experience is very disconcerting to a designer, but it has the advantage that it leads to very rapid improvement. Each feature that fails or gives rise to complaint is subject to thorough investigation, with the result that satisfactory arrangements are soon attained. With highly skilled engineers and frequent returns to the makers' yard motors would suffer fewer breakdowns, but the process of evolution would be slower, and possibly less thorough. Certainly it would not be so distinctly in the direction of simplicity and fool-proofness."

"Cylinder-heads which have given much trouble in almost every make of engine. The Werkspoor cylinders are in one piece with the heads. The cooling-water thus surrounds the hottest parts of the cylinder where it is most effective, whereas, in the majority of constructions heavy masses of cast-iron are found all around the cylinder top. The casting is entirely without ribs liable to crack. The fuel-valve is placed out of the centre, instead of being squeezed in between inlet and exhaust valves; a more symmetrical design of the head is thus attained, and, what is more important, a considerable cooling space is left around each of the four valve-cages. The four covers in the outer wall make a survey and cleaning of the interior exceedingly easy, and the formation of scale can be easily detected, and the scale removed. Since all these improvements have been applied, cracked cylinder-heads have become absolutely a thing of the past with the Werkspoor engines."

Four-Cycle Versus Two-Cycle Marine Diesel Engines

Additional Arguments in Favor of the Four-Cycle Principle Offered by Franco Tosi

By R. T. DURRAN, British Representative of Franco Tosi

Franco Tosi have had very extensive experience with the two-stroke type of engine, having built a large number of these engines in sizes up to 2400 B.H.P. for both land and marine service; moreover, they were the first to construct (in 1910) two-stroke engines having a cylinder diameter of 630 mm. These engines are still in successful operation. The decision to adopt the four-stroke type of engine was not, therefore, taken for commercial reasons, but solely because Messrs. Tosi, having had a large experience with both types of engines, arrived at the conclusion that the four-stroke type of engine had superior merits.

The two scavenging-pumps with their gear necessary for the two-stroke engine, are undoubtedly more complicated than the two additional cylinders of the four-stroke engine. The two-stroke engine has two cylinders different from all the others, whilst in the four-stroke engine any additional cylinders which may be necessary, are exact duplicates of the others, representing of course, a constructional advantage. Apart from this, the scavenging receivers of the two-stroke engine take up considerable space, as will be noticed from the photo, in the June issue of "Motorship."

Franco Tosi lay particular stress on the point that the quantity of fuel burnt per square centimetre section of cylinder in the four-stroke engine is much less than in the two-stroke engine. If one multiplies the number of h.p. developed in one cylinder by the number of grammes of fuel burnt per h.p. and divides by the sectional area in sq. cms. of the cylinder, it can be seen that in an ordinary four-stroke engine 10 grammes per sq. cm. cylinder, and in a high speed four-stroke engine from 15 to 16 grammes per sq. cm. are burnt, whereas in a slow speed two-stroke engine 30 grammes per sq. cm. are burnt. It is thus apparent that the internal temperature of the cylinder of a two-stroke engine will be much higher than that of a four-stroke engine, consequently the walls of the combustion chamber and

the piston rings operate under much more favorable conditions in the four-stroke engine.

In a two-stroke engine designed with port scavenging, i.e., without scavenging valves in the cylinder heads, there is considerable risk of some exhaust gas remaining in the cylinders, because the expulsion of the gas cannot be effected so well as in two-stroke engine with scavenging valves in the cylinder heads, or in the four-stroke engine with exhaust valves, and as a consequence, the temperature in the region of the inert gas zone will, of course, be much higher than in engines where the burnt gases are completely expelled.

From what has been stated in the preceding paragraph it is obvious that it is possible to run with overcharge in the four-stroke engine. It is, therefore, quite feasible to overcharge the four-stroke engine in submarines until the fuel burnt reaches 20 grammes per sq. cm. of cylinder section, whilst in the two-stroke engine the corresponding overcharge would bring the fuel burnt up to 40 grammes per sq. cm., which is, of course, not permissible.

It is evident that the pressure of the scavenging air decreases with the reduction of the speed of the two-stroke engine; in fact, the output of the scavenging pump decreases in direct proportion with the number of revolutions, whilst the resistance to the passage through the valves or scavenging ports to the discharge ports and pipes decreases as the square of the speed, i.e., as the square of the number of revolutions; thus, if the scavenging pressure in an engine running at 300 r.p.m. is 0.6 it will be 6.15 at 150 r.p.m., therefore the pressure of the scavenging air remaining in the engine cylinder is also much lower when running with a small number of revolutions. As a consequence, the compression is also much lower, and this explains the difficulty of obtaining sufficient compression at low speed. This drawback can be remedied in the two-stroke engine by making the scavenging period variable, but

such an arrangement is not a very simple one.

It is of course, true that the four-stroke engine has to be provided with exhaust valves which are not necessary in the two-stroke engine, but is it not better to have these exhaust valves, which practice has shown do not give any trouble when properly constructed and cooled (in small engines cooling is not necessary), rather than have a very high-temperature in the combustion chamber with its accompanying risks of cracks, corrosions of the walls, encrustation of the piston rings, all inherent in the two-stroke engine, in which, as pointed out above, a fuel consumption of 30 grammes per sq. cm. is obtained. A comparison with a hot-bulb engine does not apply in this case, as with these the mean pressures are generally very low, the fuel burnt per sq. cm. being not more than 5 to 6 grammes per sq. cm. of cylinder area.

The camshafts in the Tosi's two-stroke engine do, in fact, run at half the speed of the driving shaft, but the arrangement suggested by a Mr. Douglas in the British "Motorship and Motorboat" of June 27th, 1918, has not been adopted, because it would involve doubling the number of fuel-pump pistons, as in the two-stroke engine the fuel-oil is introduced during each revolution, whereas, in the four-stroke engine only in every second revolution.

In conclusion, I would like to draw your attention to the fact that as regards lubricating-oil consumption, the figures for the two-cycle engine and the four-cycle engine were unfortunately reversed in the description published in the March issue of "Motorship." It is the four-cycle engine which has the lower consumption of 0.018 pounds of b.h.p. per hour, whereas the two-cycle has a consumption of 0.0334 pounds. [A correction to this effect was made in the April issue of "Motorship," the typographical error having been detected by ourselves after publication. The article was written by Mr. Lisle while away at Chicago and published without his seeing the proof.—Editor.]

TRIALS OF THE M.S. "MARYLAND"

The auxiliary motorship "Maryland" of the Texas Co. recently ran successful trials with her new McIntosh & Seymour Diesel engines, and we hope to publish a complete account in our March issue. Two engines of 300 B.H.P.—not 500 B.H.P. as stated in our last issue—are installed.

SPANISH COMPANY PURCHASE AMERICAN MOTORSHIP

Mr. Francis Bustillo of the Compania Transmediterranea of Barcelona and New York, founded in 1917, recently purchased a 3,500 ton wooden auxiliary-schooner through the direct medium of "Motorship." This vessel was built by the Elliott Bay Shipbuilding Co. of Seattle, Wash., and is propelled by two 500 B.H.P. Winton Diesel engines. This Spanish company has a capital of \$10,950,000.00 paid-up and own 55 ships totalling 70,084 gross tons.

THE MERCHANT SHIP SITUATION ACROSS THE "HERRING POND"

(Extracted from a British Contemporary)

"The time has come—in fact, it is long since overdue—for a reconsideration of shipbuilding policy in this country. The opportunity should

be taken now (for it is an opportunity that could never occur unless shipbuilding were governed by the State, allowing the placing of orders on a far larger scale than under peace conditions) of building a fleet of modern motorships. With proper precautions, good supervision, and the employment of the expert knowledge that exists in the country, no failure is possible, for motor ship development has stretched far beyond that stage. The blind, wholesale construction of large standardized steamships is uneconomical, and if proceeded in beyond a certain point will become calamitous."

THE "I.C. S." BALL-BEARING SAFETY-TYPE SHIPS' TELEGRAPH

The manufacturers of this modern type of Engine-Signal Equipment fully appreciate the exacting and important service required of such instruments in the proper control of handling marine engines. The greatest possible accuracy and dependability are prime considerations in the operation of any engine-signal equipment, and the matter of cost has not been permitted to influence the design or construction of this type, the object of the manufacturers having been to produce a strictly high-grade equipment which would be simple, reliable, accurate and

safe under the most severe conditions of use, at the same time being easily operated and entirely free from excessive strains on all connections. These characteristics have all been fully met on test.

The "I.C. S." equipment employs but one connecting cable for transmitting signals from bridge to engine-room, and a similar single cable for transmitting the return-signal from engine-room to bridge. An automatic and positive take-up is used at the receiving-end of each cable and the transmitter-lever are automatically centered in each signal position. Frictionless bearings are fitted to all instruments. The engine-room indicator is equipped with a robust and simple type of safety alarm which is actuated by the wrong movement of the engine or turbine control-levers, giving the engineer a timely and effective warning of mistake in event of an attempt to operate the engines in opposite direction to the indicator of the engine-room dial. This device has proved its value and effectiveness during five years daily service in eight fast Sound steamers of the Puget Sound Navigation Company's fleet, some of which make sixteen landings per day. These steamers have a record for mileage and safety of operation equal to any similar fleet in the world.



The Motorship "Bayard," sister vessel to the M.S. "Borgland." Owing to the presence of the dock-buildings on one side and lighters on the other, it was not possible for "Motorship" to secure a good picture of the M.S. "Borgland" while she was in New York harbor. She sailed for Montevideo on Jan. 6th, 1919.

Another New Norwegian Motorship

The Motorship "Borgland" Visits New York on Her Maiden Voyage

A very striking indication of the great value of motorships to a country that has little or no natural fuel, as well as to a country that has a great supply, was demonstrated by the case of the M. S. "Borgland," which visited New York on her maiden voyage towards the end of December last. She had been completed some months previously; but, was unable to sail owing to their being no oil-fuel available until the return of a sister motorship from America. The economy of this sister vessel—the "George Washington" was so great that she was able to turn over a large quantity of her fuel-oil to the M. S. "Borgland" upon reaching Norway and yet have enough left to take herself back to America. Had the M.S. "George Washington" been steam-driven she would have had no available fuel for the M.S. "Borgland," and the latter still would be in Norway.

The M.S. "Borgland" is the fifth of a number of large twin-screw Diesel-driven motorships built at the shipyard of the Akers Mek Vaerkstad,

Christiania, Norway, where several additional motorships are nearing completion, the other four in service being the "Brazil"; "Bayard," "George Washington," and "Bonheur." The m. s. "Borgland" is owned by Mr. Fred Olsen of Christiania.

This vessel has the following dimensions:—

Length	362 ft.
Breadth	51.2 ft.
Depth	25.5 ft.
Power	2,000 I.H.P.
Engine speed	150 R. P. M.
Speed (loaded) of ship	10 knots
Max. speed (light) on maiden voyage	11½ knots
Gross tonnage	3,700 tons
Dead-weight-capacity	6,500 tons (about)
Engine-room crew	10 men
Daily fuel-consumption	7 tons

She is propelled by twin six-cylinder reversible, four-cycle type Burmeister & Wain designed Diesel oil-engines built by the Akers Co. under license. They are of 540 mm. (21.259") bore by 730 mm. (28.740") stroke and each develops 1000 I.H.P. at

150 R.P.M. This speed is too high for engines of their power say the engineers of the ship, and we are inclined to agree with them, as a speed of about 120 to 125 R.P.M. would be better in many ways, especially as the engines are of the single-acting cross-head type.

In design they follow the other new Burmeister & Wain motors, except that the pistons are oil-cooled thru the piston-rods instead of by salt-water cooling thru telescopic tubes, consequently the oil when it reaches the guides may be a little hotter than is desirable. Also the higher speed than usual may be partly responsible for the heat that existed in the crank-chamber during the voyage to the U. S. A. The principle reason for the heat was the poor quality of lubricating-oil used on the trip. [This now has been replaced by Vacuum D.T.E. for the main bearings, and Vacuum R.R. for the air-compressors.] The heat in the crank-chamber, while not high enough to cause any worry or unreliability of the engines, was sufficient to leave a heavy black deposit from this impure oil on the walls of the crank-chamber.

The arrangement of auxiliary machinery is very similar to the of the M.S. "Bullaren" described in our last issue, electricity being fitted thruout for the winches, pumps, steering-gear, and there is the usual small oil-fired donkey-boller for the heating of the ship. The three auxiliary Diesel-engines driving generators are of 80 I.H.P. each, and also were built at the Akers works. The engine-room staff consisted of the Chief-Engineer, 2nd Engineer, 3rd Engineer, six oilers and cleaners, or motormen as they sometimes are termed, and one electrician. The guarantee-engineer from Burmeister & Wain also was on board and we presume that later on he will be replaced by a 1st engineer, making eleven men all told.

On the way to New York the "Borgland" experienced the worst of the terrible weather that existed in the Atlantic and North Sea during December last, and so took 19 days for the trip. On some days, however, she averaged 11½ Knots. For her size, power, and revolutions we should estimate that an average of 9½ Knots would be a very excellent loaded sea-speed to maintain.

IMPORTANT DIESEL-ENGINE TESTS

Commencing with the March issue of "Motorship" we shall publish a detailed report of a series of valuable Diesel-engine trials held under the supervision of the British Admiralty. The engines in question were built for the British navy during the war. Pressure on space prevents their inclusion in this issue.



Reading left to right—The Chief-Engineer; Guarantee-Engineer; Second-Engineer, and Third-Engineer of the M.S. "Borgland" are interested in the description of the M.S. "Bullaren" in the January, 1919, issue of "Motorship."

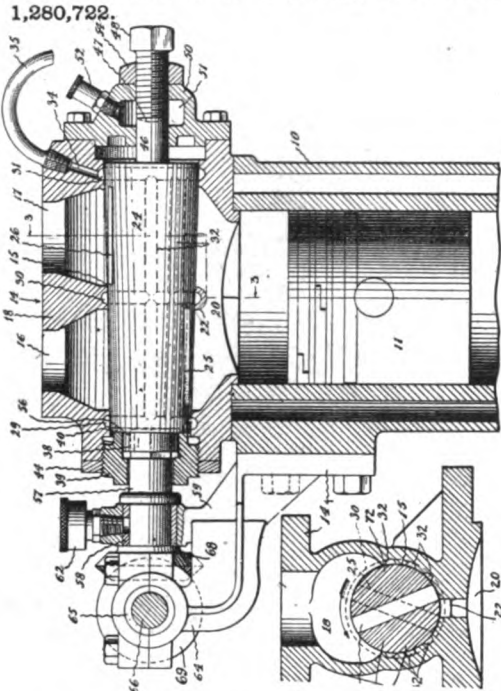
"Motorship" Illustrated Patent Record*

Selected Abstracts of Recent Published Patents of Internal Combustion Engines

Copies of original specifications may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."

*Compiled and described by H. Schreck, M. A. Soc. Mech. Eng.

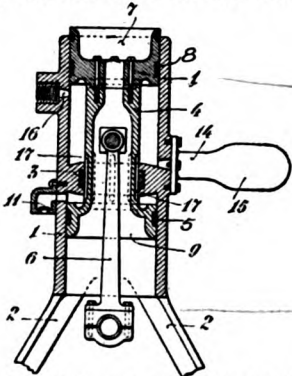
1,280,722. Oct. 8, 1918. Rotary Valve, G. V. Harriman, of New York, N. Y.
This patent refers to the distribution of inlet and exhaust gases by a rotary valve which is arranged in the cylinder head. The inlet connection is at 16 and the exhaust connection at 17. The rotary valve which is



Inventor:

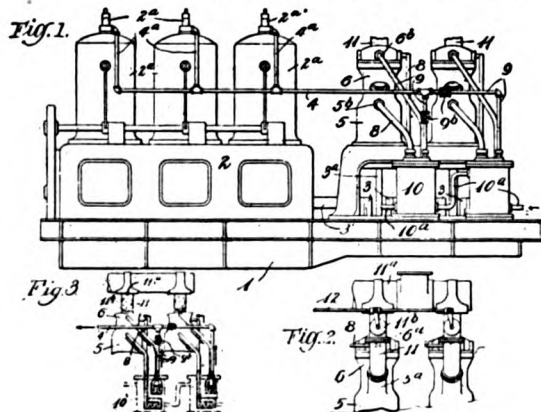
being turned at one-fourth of the speed of the crankshaft controls the admission and escape of the gases by means of the slots 25 and 26. Referring to the illustration of the cross section of the valve it will be noticed that the exhaust slot has just cleared the combustion chamber and the intake begins to open. The illustration indicates a very short period of port opening, but this may be different on the actual construction of the engine.

1,279,334. Sept. 17, 1918. Two-stroke cycle Engines. C. A. Hallbaeck, of Helsingborg, Sweden.
This invention relates to a novel design of a two-cycle engine. The cylinder is open at both ends, a central partition is dividing the same in two chambers, that is, the upper one with the fuel inlet at 14, and exhaust at 16, and the lower one for compressing the



scavenging air which enters at 11 and is discharged into the upper or working cylinder through the grooves 14. Inventor claims for his engine noiseless running and dispensation with any watercooling. Altho this latter point may come out different, the former is worth while to be studied as this engine evidently will eliminate the difficulty of other single-acting two-cycle engines, that the pressure on the bearings is all the time in one direction.

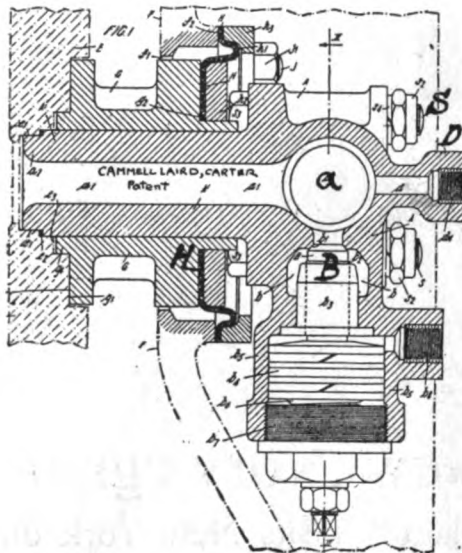
1,279,085. Sept. 17, 1918. Air-System for Diesel-Engines. G. C. Davison, of New London, Conn., Assignor to Electric Boat Co., of New York, N. Y.
This invention involves the employment of two



compressors on an engine, each of which is operated independently and each one is to be large enough to supply the air in case one of them should become disabled during operation. The disabled compressor can be put out of commission by closing the respective air valves in the air intake as well as discharge line.

The inventor suggests this arrangement as particularly advisable on submarine engines.

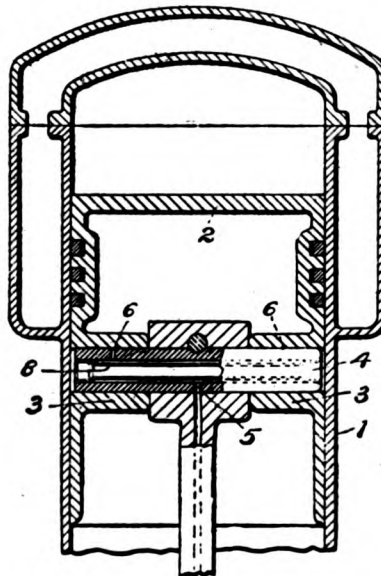
120,226. 1917. Valve Fitting in Opposed Piston Engines. Cammell, Laird & Co., Ltd., of Birkenhead, and Sir G. C. Carter, of Bromborough, and L. G. McFarlane, of Liverpool (British Patent).
This invention relates to a special construction which object it is to overcome the difficulties which have been experienced on the cylinders of Diesel-engines of the opposed piston type at the place where the con-



nections are provided to receive the different valves. The inventors do not connect any more at this place the casting of cylinder liner and jacket by a solid boss or integral cast channel, but as the illustration shows a valve chamber "a" is by means of bolts S drawn up directly to the cylinder liner and the water jacket is closed up by a flexible member H. The illustration shows one of the valve chambers which carries at B the safety valve, at D the indicator cock, and a starting air valve (not shown), the other chamber is simpler as it only carries the fuel injection valve.

1,280,117. Sept. 24, 1918. Detail in Lubrication of Wrist Pins. A. Winton, of Lakewood, O.

The invention relates to a detail in the arrangement of lubrication of wrist pins. On engines provided with forced lubrication and on which the oil is supplied through the connecting rod, through the wrist pin



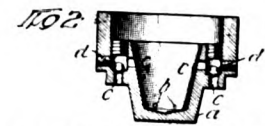
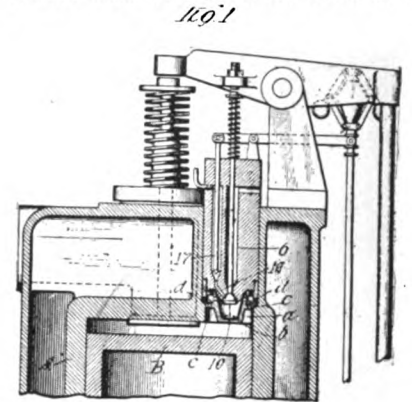
and then to the bearing of the later, the pin itself may be hollow which space will require some time to be filled up with oil when the engine is started. In order to shorten this time interval, that is, until the bearing really gets oil, the inventor has decreased the volume of this oil chamber by inserting an internal tube as will be seen in detail on the accompanying cut.

1,245,312. Nov. 6, 1917. The Hvid Engine, E. B. Blakely, of Chicago, Ill. Assignor to The R. M. Hvid Co., of Chicago, Ill.

The Hvid engine itself is covered by the patents 1,134,857 and 1,134,858 which were granted April 6, 1915. The principle of this invention may be briefly recapitulated. The fuel supply is controlled by a valve 17 and its admission into a special cup "a" is effected by the opening of needle 10 during the suction stroke of the engine. The oil is being vola-

tilized by the heat of this cup and is ignited by the heat of the compressed air entering through the openings "b" through which the oil is later forced out in return into the cylinder by that part of the oil which had been ignited inside of the cup.

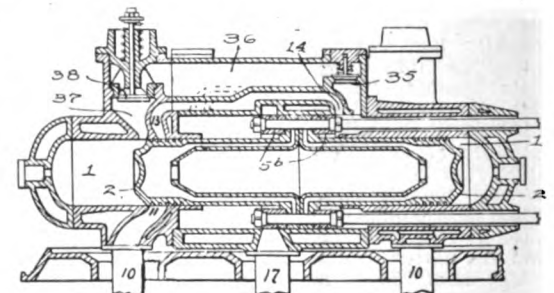
On smaller sizes of engines the holes of the cup



become so small that the highly compressed air from the cylinder compression space cannot pass into the confined space of the cup within the allowed time interval. This causes late firing and with it inefficiency. To overcome this difficulty our invention provides additional inlet ports "c" through which the compressed air will find a liberal admittance and a ball valve prevents a return flow of the gases.

1,282,217. Oct. 22, 1918. Double-acting Two-Cycle Engine. M. J. Goldberg, of Oil City, Pa.

This invention refers to a novel design in which a pair of cylinders is arranged in tandem with closed outer ends and their opposed inner ends open. The power of the piston is transmitted instead of by a connecting rod by two push rods which are connected to an outer flange of the piston. This flange serves at the same time as the scavenging pump with its inlet at 17. This air is discharged at 14, and after

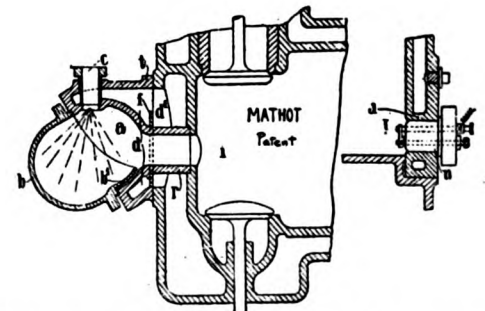


this port will be covered by the piston air of higher pressure will be supplied through valve 35 into the storage chamber 36. When the piston approaches either end of its stroke it will uncover at first the exhaust ports 11, then admit the scavenging air through port 13 and on the return stroke admit a "supercharge" to the cylinder from storage 36 which is controlled by the mechanically operated valve 38 and the ports 37.

The cooling of the piston is suggested by an arrangement of telescopic pipes which may be extended from the two push rods through the rear cover of the cylinder.

120,335. 1918. Detachable Vaporizer, R. E. Mathot, of London. (British Patent.)

This invention refers to a detachable and divided water cooled vaporizer. The water cooled part a of the vaporizer is provided with a jacket d which is in communication with the jacket of the cylinder, and the



amount of cooling from such water can be regulated by an adjustable partition plate f. C is the connection for the fuel sprayer, and the vaporizer itself is built in such a way that it can be readily mounted in place of the ignition plug used when gaseous fuel is employed.